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# ECONOMIC GEOGRAPHY

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SOME ASPECTS OF THE U. S. MINERAL SELF-SUFFICIENCY
E. Willard Miller

THE THAILAND-BURMA RAILWAY
Charles A. Fisher

THE POPULATION PROBLEM IN EGYPT
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IRON AND STEEL INDUSTRY IN JAPAN
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STABILITY OF ANNUAL EMPLOYMENT—CINCINNATI AND SELECTED CITIES
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A GROWTH MAP FOR THE MANCHESTER REGION
Henry Rees

ROCHESTER, MINNESOTA: A PROFESSIONAL TOWN
Merna Irene Fletcher

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## MINERAL POLICY

SINCE Eolithic workers in flint sought out in the chalk cliffs of East Anglia the choicest bits of stone for their primitive rostro-carinate tools, and their successors in Paleolithic progress opened up the first flint quarries in Britain and elsewhere, man's use of minerals has substantially modified and promoted his cultural development. When his pristine mind awakened to the concept of design, when mass and symmetry and function became related in his will to do and make, his chipped flint tools became the first steps on his "rise to Parnassus."

When he discovered metals, and won tin and copper from their ores to make bronze, his movement toward civilization was so accelerated that his slowly-developing mind could scarce keep pace with his technological progress. His world became a wonderful place to live in. Winning and working of iron opened his mental horizons to vistas far beyond any earlier dream, and his world became glorious.

Since that epochal development, minerals have constantly given man new worlds of culture to discover and exploit. In every expansion of his mental sphere they have played their part. His every policy has been shaped by their applicability to his needs.

Today, supply of many minerals becomes precarious. Peoples of the world struggle to obtain enough for their economy, their very survival. Mineral resources mold the future, shape the destinies of man. The wonder and glory of his world rest upon his mineral policy.

ECONOMIC GEOGRAPHY

VOL. 23 APRIL, 1947 No. 2

# SOME ASPECTS OF THE UNITED STATES MINERAL SELF-SUFFICIENCY

*E. Willard Miller*

THE United States has long been the leading producer and consumer of minerals in the world. The strength of our country in war and its high standards of living in peace are based primarily on the development of its mineral resources. From 1880 to 1944 the value of the annual production of the mining industry increased 18 fold from $367,000,000 to $8,452,000,000. During the past war the minerals industry, and particularly metal mining, extended itself more than any other in order to attain needed production. We have consumed our high grade minerals faster than any of the major countries and the past war has been tremendous drain on our resources. Consequently, many conflicting viewpoints as to our remaining mineral reserves have been presented in recent years. Some of them are: (1) our minerals for all practical purposes are already exhausted; (2) large reserves are still to be discovered by the use of new methods; and (3) our present reserves are sufficient for all needs.

It is, therefore, appropriate to determine the self-sufficiency of the United States in its mineral needs. In order to evaluate conflicting viewpoints, a series of charts have been prepared to show proportion of domestic mineral production in relation to our total consumption for the years 1930 to 1944 or 1945.

## POWER MINERALS

Figure one is on self-sufficiency of power minerals of which petroleum and coal are the two principal. Of them our supplies have been more than adequate. United States coal reserves are still tremendous and present proved reserves will last until 6050 A. D., more than 4000 years hence. Our greatest concern lies in the rather rapid depletion of high grade coking coals. Petroleum reserves are much smaller than for coal. At present there are 20,000,000,000 barrels of proved reserves. In recent years our annual rate of production has been close to 1,500,000,000 barrels. Discovery rate of new fields is decreasing at an alarming pace and total potential and proved reserves appear at this time to give only a 40 to 50 year supply. However, supply of relatively high cost petroleum from oil shales and coal will yield an adequate supply for several hundred years. The problem, therefore, is not one of scarce raw materials, but is instead an economic one, which no doubt will not be solved so long as crude petroleum is obtainable in this country or abroad at current or materially higher prices.

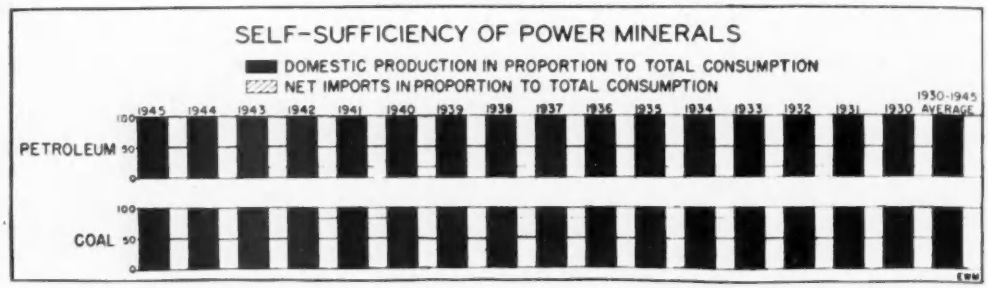
SELF-SUFFICIENCY OF POWER MINERALS
DOMESTIC PRODUCTION IN PROPORTION TO TOTAL CONSUMPTION
NET IMPORTS IN PROPORTION TO TOTAL CONSUMPTION
1945 1944 1943 1942 1941 1940 1939 1938 1937 1936 1935 1934 1933 1932 1931 1930 1930-1945 AVERAGE
PETROLEUM
COAL
100
50
0
EWW

FIGURE 1.—The United States is well endowed with coal and petroleum and has always been a surplus producing nation.

### IRON AND FERRO ALLOYS

Figure two shows self-sufficiency of iron and ferro alloys. United States is well supplied with iron and is essentially 100 per cent self-sufficient. Present commercial reserves of 5,478,000,000 tons of iron ore are sufficient for an additional 65 years. The long term future of our iron ores will depend on metallurgical advance in use of low grade ores of which present estimates are placed at 50 billion tons. United States is self-sufficient, at present, in only one of the ferro alloys, that is molybdenum. The large molybdenum deposits at Climax, Colorado, will supply our needs for at least another 500 years. As result of discoveries in recent years, position of tungsten and vanadium has improved so that we are supplying approximately half our domestic needs. The United States has never been able to supply more than 15 per cent of its needs in manganese. However, there are abun-

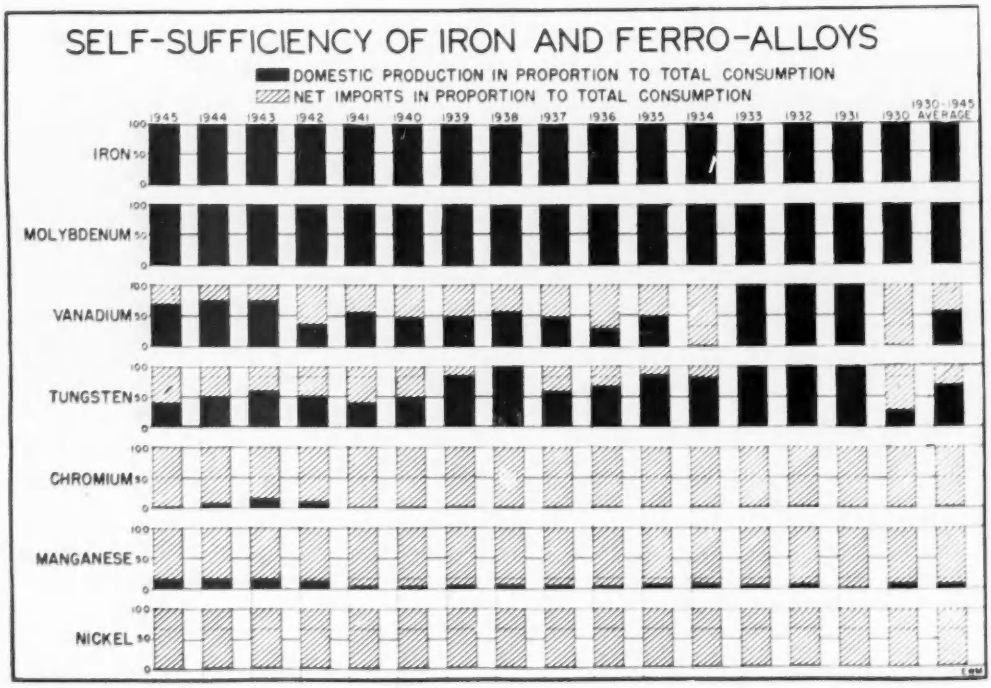


FIGURE 2.—The United States is well supplied with iron ore but is self-sufficient in only one of the ferro alloys, molybdenum.

dant supplies of low grade ores in a number of regions. The problem is to find a method of concentrating the ores for commercial uses in order to reduce costs. United States is lowest in reserves of chromium and nickel. Production of chromium increased somewhat under war stimulus but known deposits are largely submarginal. United States has essentially no nickel, but Canada, the world's largest producer, supplies our needs close at hand.

### NON-FERROUS METALS

Let us now consider some of the principal non-ferrous metals (Figure 3). During war years United States lost its self-sufficiency in copper, lead and zinc. Our position is now, and no doubt will continue to be, that of an importer rather than an exporter of a large proportion of these metals. Proved copper reserves will give United States a supply for only 34 years of which much of the reserve is low grade ore. If copper prices remain high we shall be nearly self-sufficient for the next ten years and then our self-sufficiency will gradually decline as the ore is depleted. Reserves of lead and zinc are not so satisfactory as those of copper, as we have only a 10 year supply of lead and a 17 year reserve of zinc. We shall continue to be large importers of both metals. Although we have supplied over 70 per cent of our needs in mercury from domestic sources, it is estimated that 96 per cent of our original known commercial reserves are exhausted. We shall gradually become a heavier im-

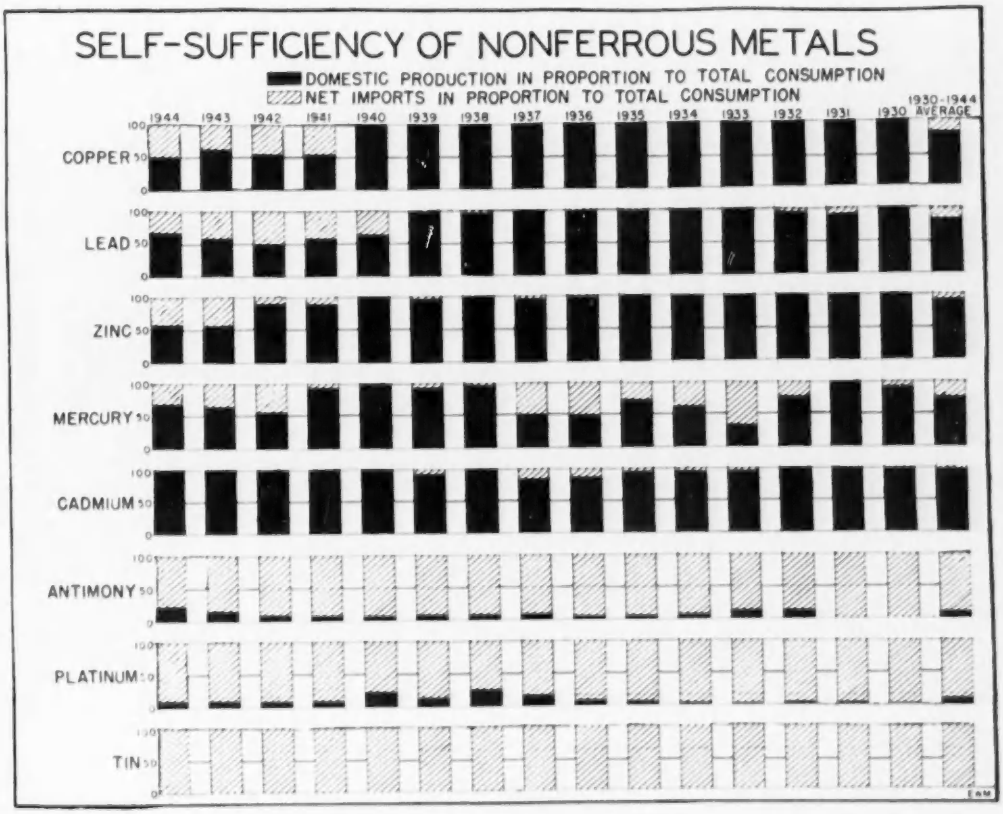


FIGURE 3.—Our non-ferrous metals are being rapidly depleted. Dependence on foreign sources will gradually rise.

porter of mercury. United States has been self-sufficient in cadmium, but since it is largely a by-product of other metals, notably zinc and lead, our self-sufficiency will decline as their production decreases. Our reserves of antimony are poor and are presently supplied largely as a by-product of zinc and lead smelting. There are no prospects to improve our self-sufficiency. Platinum has also been one of our great deficiencies and a large share of production is a by-product of gold and copper mining. United States has no known source of tin and our entire supply must be imported. Of all categories of minerals, our reserve position is poorest in nonferrous metals.

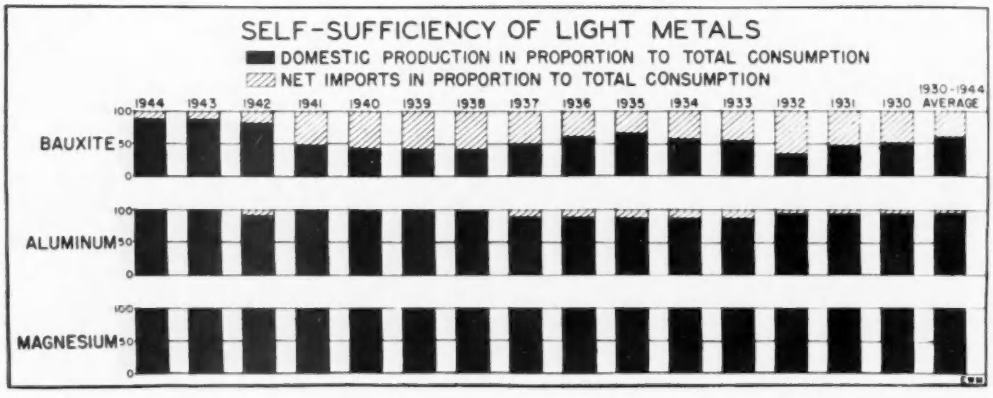


FIGURE 4.—The light metal industries are expanding rapidly as shown by our increasing self-sufficiency.

## LIGHT METALS

In recent years two new light metals, aluminum and magnesium (Figure 4), have had tremendously increased production. Magnesium, produced from dolomite, salt brines, magnesite, and residues from potash manufacturing, has unlimited reserves. United States production rose from 6261 tons in 1940 to 157,100 in 1944 making us the world's largest producer and exporter. Production of aluminum has also expanded remarkably since 1940. United States has always depended on imports of the aluminum ore, bauxite. From 1939 to 1943 domestic production of bauxite rose from 375,307 tons to 6,980,829 tons and our self-sufficiency rose from 47 per cent in 1941 to 87 per cent in 1944. The development of the Bayer process, in which high silica content ores can be used, and the lime-soda-sinter process, which utilizes low grade bauxite, open up the possibility that domestic low-grade bauxite may be as economical as imported bauxites. The two processes are major technological advances of the past decade in the aluminum industry and have extended our aluminum ore reserves possibly 500 years. When metallurgists perfect methods to utilize low grade clays our supply of aluminum ores will be essentially inexhaustible. Production of aluminum has also increased rapidly from 143,441 tons in 1938 to 776,446 in 1944. During the greater part of the 1930's, United States was a small importer of aluminum. In 1938 we reached 100 per cent self-sufficiency and are now one of the principal exporters. Since our supplies of light metals are so large they are now being substituted for many of the scarce metals and will be utilized even more extensively in the future.

### MINERAL FERTILIZERS

In mineral fertilizers, potash, phosphates and nitrates (Figure 5), United States has excellent reserves. Although we have no natural nitrates the nitrogen fixation process could always give us an adequate supply. Our phosphate deposits are extensive, and proved reserves

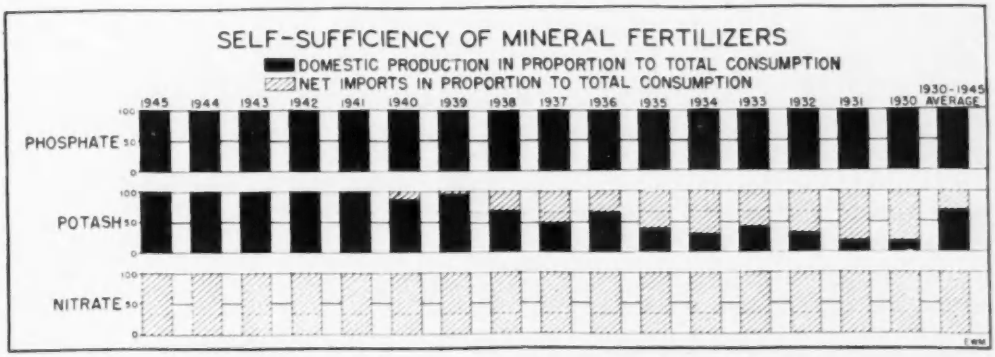
SELF-SUFFICIENCY OF MINERAL FERTILIZERS
DOMESTIC PRODUCTION IN PROPORTION TO TOTAL CONSUMPTION
NET IMPORTS IN PROPORTION TO TOTAL CONSUMPTION
1945 1944 1943 1942 1941 1940 1939 1938 1937 1936 1935 1934 1933 1932 1931 1930 1930-1945 AVERAGE
PHOSPHATE
POTASH
NITRATE
100
50
0

FIGURE 5.—The United States has large reserves of potash and phosphates, but must depend entirely on foreign imports or synthetic nitrates.

are sufficient for more than 800 years at present consumption. Until recently United States was deficient in potash but since the discoveries of extensive deposits in New Mexico and California we have been 100 per cent self-sufficient since 1941 and proved reserves are estimated at more than 100 years.

### CHEMICAL MINERALS

United States is well endowed with the chemical minerals (Figure 6). Our supplies of salt are essentially inexhaustible and we are one of the largest producers and exporters of sulphur maintaining 100 per cent self-sufficiency. While our reserves of pyrites are adequate United States is an important importer. During the 1930's we supplied about 50 per cent of our needs and during the war years increased our self-sufficiency to just over 80 per cent.

### NON-METALLIC MINERALS

United States is well endowed in a number of non-metallic minerals and is entirely deficient in several others (Figure 7). We have been self-sufficient or nearly self-sufficient in talc, slate, feldspar, fluorspar and clays. Particular kinds of clays are imported such as kaolin, fuller's earth and blue almerode

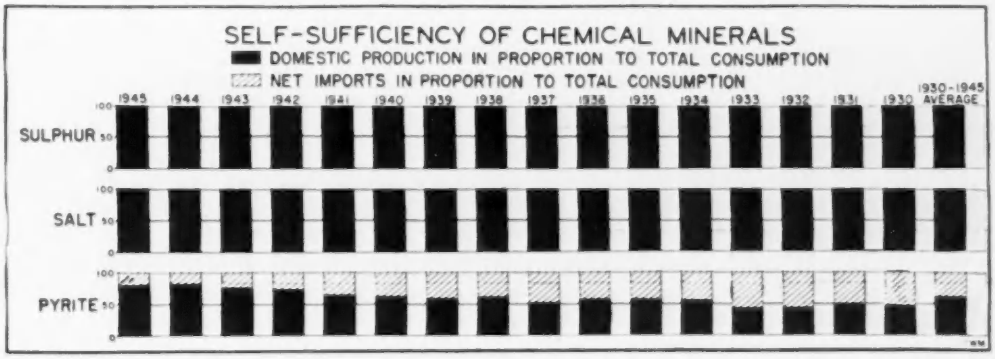
SELF-SUFFICIENCY OF CHEMICAL MINERALS
DOMESTIC PRODUCTION IN PROPORTION TO TOTAL CONSUMPTION
NET IMPORTS IN PROPORTION TO TOTAL CONSUMPTION
1945 1944 1943 1942 1941 1940 1939 1938 1937 1936 1935 1934 1933 1932 1931 1930 1930-1945 AVERAGE
SULPHUR
SALT
PYRITE
100
50
0

FIGURE 6.—The United States is an excess producer of salt and sulphur, but imports considerable quantities of pyrites.

but exports are greater than imports. Our reserves of fluorspar are small and shortly we shall become a heavy importer of this mineral. We have supplied over 80 per cent of our total needs in mica, importing special categories such as block mica and muscovite splittings. However, our mica reserves are becoming submarginal and imports will undoubtedly rise in all categories. United States has been only slightly more than 80 per cent self-sufficient in gypsum but reserves are adequate.

We are about 60 per cent self-sufficient in white arsenic, but this is largely a by-product of copper, lead and gold refining, so that our position in this mineral depends on the output of these metals. United States has essentially no production of graphite, asbestos, quartz

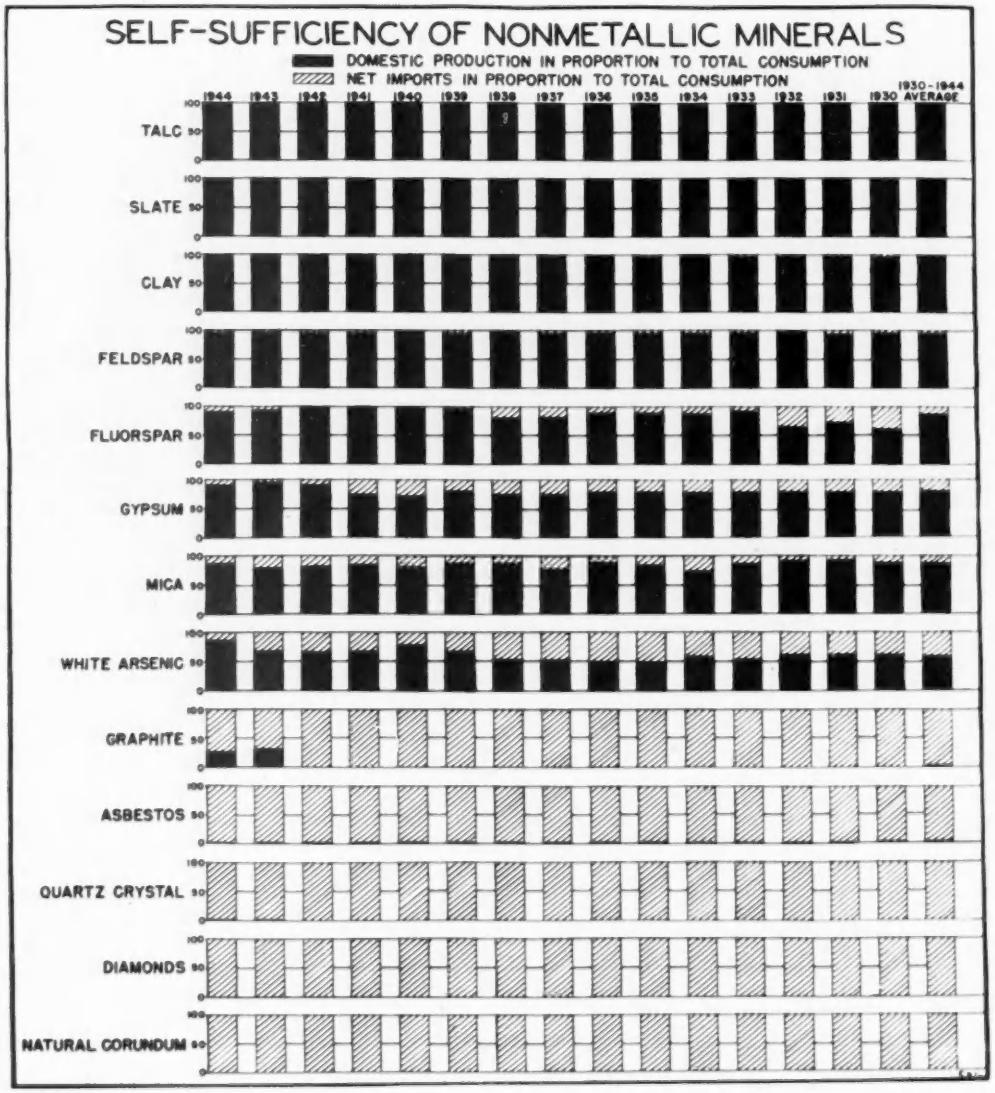


FIGURE 7.—We are essentially self-sufficient in talc, slate, clay feldspar, fluorspar, gypsum and mica and are wholly dependent on foreign sources for graphite, asbestos, quartz crystals, diamonds and natural corundum.

crystals, industrial diamonds and natural corundum, and therefore our entire supply must be imported.

## NEED FOR A SOUND MINERAL POLICY

While United States is still a "have" nation in many of the basic minerals, it is necessary that a sound mineral policy be established at once. Our present mineral economy is based on development of high grade ores. As our mineral resources are depleted or become lower grade, a new concept of thinking must be developed to maintain high productivity of the mineral industries. The new concepts will involve such factors as new techniques of exploration, fundamental research in metallurgy, sound and continuous foreign mineral policy, and new methods of conservation.

Rate of discovery of new minerals has been declining steadily for many years in United States. No major discoveries of gold or copper have been made since the early 1900's. The last outstanding lead deposit was found in the Coeur d'Alene District in Idaho in 1886. No great iron ore discoveries have been made since the finding of the Lake Superior ranges. Until recently our exploration for minerals has been largely limited to the surface with the exception of petroleum. When petroleum reserves showed signs of depletion about 30 years ago great efforts were employed in sub-surface exploration, and consequently our oil reserves were greatly increased. More carefully planned sub-surface exploration, using such instruments as the seismograph, magnetometer and others, is needed to discover new minerals that are now hidden. Our pioneer efforts in sub-surface exploration in such minerals as potash and petroleum indicate that many new discoveries may be made in the future.

As we depend more on lower grade ores and on new types of metals there is need for more fundamental research in metallurgical industries. Foremost, our postwar planning must include expanded research on methods of utilizing low grade ores. During war years rapid strides were made in this direction and new institutes are now being established for the purpose. One of the most notable developments of a new metal came during the war in the National Emergency steels in which it was possible to substitute for large amounts of chromium, nickel and other important alloying substances, smaller amounts of many alloys which used together to a large extent supplemented each other. A still more recent development has been use of a few thousandth of a per cent of boron to permit further reduction of alloys used for hardening steels. Other developments are substitution of aluminum for copper wiring and for zinc in die casting.

As our reserves are exhausted, we shall depend more heavily on imported minerals. Since we are to acquire the minerals in foreign areas a sound governmental policy based on long range planning must be inaugurated. In development of the mineral policy such factors must be considered as: (1) gradual but persistent spread of state control of minerals; (2) barriers to mineral trade such as export tariffs, quotas, subsidies, premium prices, import tariffs, taxes, postwar controls and tariffs on processed materials; (3) international price structures; (4) cartels; (5) mineral sanctions; and (6) stock piling. United States has never had a long range mineral policy. Such a policy is a necessity for future prosperity of the mineral industries.

United States has been the most wasteful nation in the world in its mineral exploitation. Since we have frequently destroyed the best we must conserve what still remains, which implies a working conservation policy which has

as its basis, the most efficient production and utilization of minerals which can be employed to meet present day demands.

Problems relating to minerals are of national concern. Continued prosperity of the mineral industries will greatly affect public welfare. As production techniques have increased, we have developed an almost unlimited demand for minerals. If we are to supply the needs of our country a sound overall mineral policy is a necessity.

# THE THAILAND-BURMA RAILWAY

*Charles A. Fisher*

THE Thailand-Burma line from Ban Pong to Thanbyuzayat, and the Kra isthmus line from Chumphon to the Pakchan estuary, both of which were built during the Japanese occupation of the areas, mark the realization, in greatly changed circumstances, and for very different purposes, of projects which date from earliest days of railway enterprise in South East Asia.

Thailand and Burma, Siamese twins of geography, are joined back to back by a long and rugged spine of mountains, which, in view of the essentially river basin character of both states, has traditionally been a relatively neglected zone. Though the early history of the two very similar lands consists largely of mutual rivalry and warfare, their different seaward aspects served in the nineteenth century to focus their attention in opposite directions. Thus, while certain ancient overland trade routes continued to carry a small trickle of commerce between them, differing orientation of their emergent economic organization gave little justification for development of modern rail connexions linking the two together.

At the same time, however, general configuration of South East Asia as a whole inevitably suggested desirability of such a link. Acquisition of Singapore by Britain in 1819 gave that country control of the sea route to China, and though initial rivalry to Britain in this respect had come from the Dutch, the French soon began to make an increasingly powerful bid for the China trade. Grandiose visions of diverting the Yangtze traffic down either the Mekong or the Red River and so to French Indo-China, led, in the 1860's to the idea of cutting a canal through the Kra isthmus, and so avoiding alike a detour of some 400 to 600 miles and, much more important, the controlling hand of the British.

Unfortunately for the French, both the river and canal projects were based on inadequate geographical knowledge, and ultimately fell through, though the opening of the Yunnan railway in 1910 may be regarded as a partial and modified realization of the original schemes. Despite their efforts to preserve secrecy, the French had succeeded in directing attention to the ancient route across the Kra isthmus, and British authorities thereupon awoke to its strategic significance. Canals were very much in fashion in the middle of the nineteenth century, and the supposed parallel between Kra and Suez came in for considerable attention. But surveys undertaken on behalf of the Indian Government by Captains Fraser and Furlong in 1863 revealed that the terrain was most uninviting, and meanwhile, as the French lost interest in the scheme, the British came to realize that, Malaya being no Africa, the saving in distance would never repay cost of cutting the canal. An alternative proposal to build a railway across the isthmus was actively canvassed by its promoters, two military gentlemen already mentioned, who argued, apparently in complete ignorance of charges entailed by a double break of bulk, that it would greatly reduce cost of freight transport between England and China.

Thus the Kra canal never materialized, nor, one need hardly add, did the

suggested alternative railway arouse much interest. Obviously, as Reclus pointed out in the 1883 edition of the Géographie Universelle, if a line were to be built between Burma and Siam the most sensible route for it lay much farther to the north, at a latitude where it could link Rangoon directly with Bangkok.

As a mere local scheme, no real economic argument could ever be seriously advanced in support of such a railway, but in closing decades of the nineteenth century, after completion of the first American transcontinental lines, long distance railways were as much in vogue as canals had been a generation before. In 1885 an elaborate project was mooted by two British engineers, Messrs. Hallett and Colquhoun, for tapping the south-west China trade by rail. They envisaged a British owned line from Moulmein to Raheng, there to link up with a proposed Siamese line running from Bangkok to the borders of Yunnan. Such a project would, therefore, incidentally, have provided direct communication between the Siamese and Burmese capitals, and for a long time received serious consideration, especially in Bangkok. But British investors refused to be drawn into what they considered a very dubious speculation, and in view of the lengthy mountainous section involved it seems certain that the main traffic of the proposed railway, that of through freight to and from China, could never have have paid its way against slower but much cheaper ocean shipping.

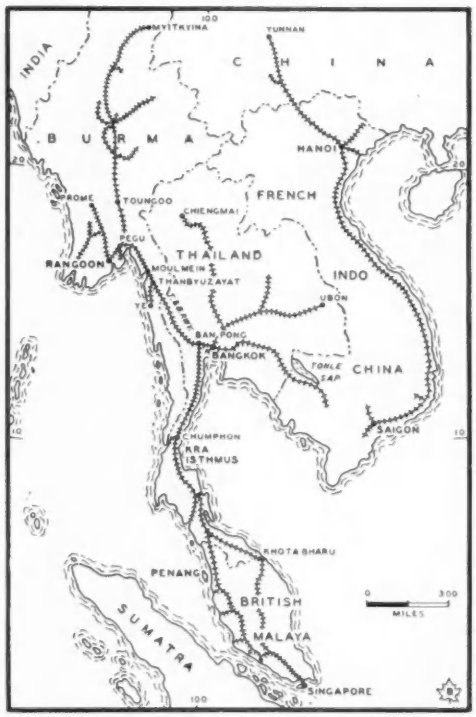


FIGURE 1.—Railways of Burma, Thailand, Indo-China and Malaya. The Thailand-Burma Railway runs from Ban Pong to Thanbyuzayat, across the long rugged spine of mountains by which Thailand and Burma, Siamese Twins of geography, are joined back to back. The line, and the Kra isthmus line from Chumphon to the Pakchan estuary were both built during the Japanese occupation of the area, in part by labor of prisoners of war including British, Australians, Americans, Dutch, Chinese and others. It is estimated that 15,000 Allied prisoners and 150,000 Asiatics lost their lives in the building of the Thailand-Burma Railway alone. Its length of 245 miles cost 675 lives a mile, laborers dying like flies from tropical ulcers, malaria, dysentery, avitaminosis, and finally cholera.

So the project, like its predecessors, was shelved and thereafter, though the question of some link between the Siamese and Burmese systems has periodically been revived, the two developed independently and with no foreseeable prospect of ever meeting. On the one hand no great economic need existed for such a link, while, on the other, it was always feared that its construction would entail such a high death rate as to render it excessively expensive. Siamese labourers would never consent to work on such a project, and the Government looked askance at the importation of large numbers of Chinese coolies. Later, extended development of air transport removed the force of the most potent argument in favour of swifter overland communication between

Rangoon and Bangkok, so that by 1939 it had become largely a forgotten issue.

Events of the Pacific war, however, transformed the situation almost at once. Though Japanese forces swiftly overwhelmed the small allied garrisons throughout South East Asia, the enemy realized that the vital test lay in his ability to hold the newly won territories against counter attack which must assuredly follow. Before long it became clear that the sea power of Japan would be utterly inadequate to stand the strain, and, unless she could integrate by land what she had conquered largely by sea, the outlying possessions would ultimately fall to the superior sea power of the Allies. Thus filling in most important gaps in the railway network of South East Asia was seen as imperative necessity, and among them that between Thailand and Burma clearly headed the list. Furthermore, possession of tens of thousands of allied war prisoners appeared automatically to solve the labour problem in a very neat way. It was therefore decided to undertake the task with utmost possible speed.

The belt of country, on the Siamese side, through which such a railway must pass, forms part of a small but distinctive region, which may be termed the Western Mountain Fringe, usually ignored in geographical accounts of the country, which follow the four-fold division into North, East, South and Centre first suggested by W. A. Graham. It consists almost entirely of an elevated tract of severely weathered karst land, whose latitude and situation subject it to heavy monsoonal rainfall.

Though erosion has in many parts dissected it into a maze of detached massifs, with numerous outliers on the eastern edges, relief of the area is dominated by the N/S trend of the ridges, of which the crests in vicinity of latitude 14°N. show an accordant level of from 4000′ to 5000′. Thus, to the engineer, as to the native cultivator, this is an extremely difficult terrain, and since opportunities elsewhere in many parts of Thailand seemed so much more promising it has been allowed to remain a jungle waste, until events of the recent war led to a change, temporary or otherwise, in local geographical values.

There are two possible ways that a railway might follow through the area, both of them ancient trade routes of minor character. The northern route from Raheng to Moulmein has already been mentioned, while the more southerly one, from Kanchanaburi to Thanbyuzayat, via the Three Pagodas Pass, has received attention, at different times from British, German and Japanese experts, and came under particularly serious consideration when the Burmese rail network was extended to Ye.

Length of new line remaining to be constructed in 1942 was roughly the same whichever route was chosen, but the southern one found favour with the Japanese, principally, it appears, because of its supposedly easier topography, though it has the further advantage of being much more direct as a means of communication between Bangkok and Rangoon, and so avoiding congestion on the existing railways of Thailand. The great attraction of the route topographically lay in the fact that it followed the valley of a navigable river, the Gwenoi the full name is the Meklong Gwenoi which means the lesser branch of the Gwenoi. The larger easterly branch is called the Meklong Gweyai) from Kanchanaburi almost to the Three Pagodas Pass.

In a practically roadless country like Thailand, rivers are by far the most important means of communication, and the Gwenoi, navigable by launches and barges for 110 miles to Lin Thin, and by small outboard motor boats even

beyond, could be used to transport the necessary materials and supplies. Moreover a road from Kanchanaburi to the pass had already been projected in 1936, as part of the Government's 18 year plan, while another, from Ban Pong, on the southern railway line, had been opened to Kanchanaburi some years previously. To construct a railway across the level plain from Ban Pong to Kanchanaburi involved no great difficulties, and could be done—as in fact it was—in a few weeks. Kanchanaburi itself, an important centre for river craft, could then be used as a major base for operations beyond.

Kanchanaburi, situated at the confluence of the two branches of the Meklong, where both emerge from the uplands, is an ancient walled town guarding the twin river routes down which invading Burmese armies have repeatedly ventured. Its economic significance derives from a large modern paper factory, using bamboo as raw material, and its function as the main marketing centre of the changwad or province, whose productive lowlands are given over principally to rice cultivation, with vegetables and fruit as subsidiary items. Abundant supplies of provisions could always be obtained there, and were transmitted, in progressively diminishing rations, upstream to the various working camps on the Thai side of the border.

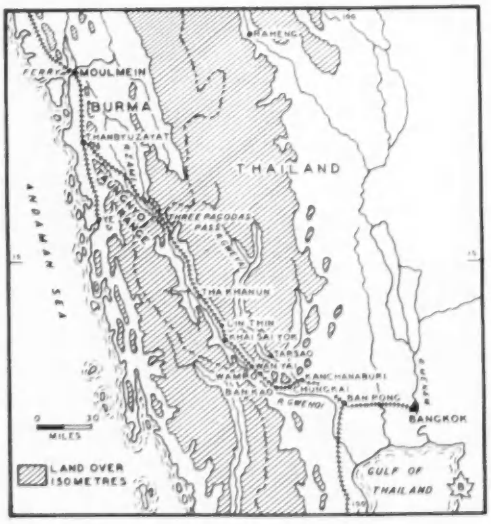


FIGURE 2.—The Thailand-Burma Railway. It extends from the lowlands of Ban Pong and Bangkok past Kanchanaburi, up over the Lin Thin plateau, by the Gwenoi River Valley route to Three Pagodas Pass through the divide and on down almost to the coast at Thanbyusayat, and thence on to Moulmein, where a ferry connects it with the other side of the estuary.

Beyond Kanchanaburi the Gweyai had to be crossed, but owing to the swampiness of its west bank in the immediate vicinity of the town, the village of Tamarkan some three miles higher up was selected as the bridging point. The river here varies in width seasonally from about 100 to 500 yards. Thence the route traverses a wide lowland, flooded annually by both streams, past the hamlets of Chungkai and Wan Lun (near the latter of which some low quality tobacco is cultivated), keeping, as far as possible, to the higher ground away from rivers, and gradually climbing above level of the Gwenoi onto a low plateau past Ban Kao.

At Wampo the surface is broken by a major N/S ridge, rising steeply above the general plateau level. Through it the Gwenoi has cut a narrow gorge and round the edge of this the Japanese engineers decided to carry the railway, on a viaduct built into the cliff face, thus avoiding lengthy tunnelling operations. The gorge marks entrance to the upper section of the valley, the river flowing in meanders incised deep into the limestone. North of Wampo the route keeps close to the line of the river, where minor N/S ridges tend to be more subdued, crossing numerous small gullies occupied by short swift-flowing tributaries, and climbing steadily throughout, often with severe gradients.

Near Lin Thin a higher level of plateau is reached and the landscape

changes in character, mainly owing to thinning out of the vegetation from almost uninterrupted jungle, in which bamboos predominate (some giant varieties, exceeding 80′, are common) to a more open type characterised by stunted trees, thorn, and scrub. This continues to the crest, i.e. the Three Pagodas Pass, a low saddle, about 1000′ above sea level, beyond which the line descends, at first along the upper valley of the Zami, and then across the Taungmyo range, finally joining the Moulmein-Ye railway at Thanbyuzayat.

Although normally described throughout as tropical monsoon country, the area traversed by the route displays considerable climatic variety, and the strictly monsoonal character should not be overstressed. The Siamese lowland sector has a threefold seasonal regime, the cool, dry, and very pleasant season from early November to February giving place gradually to the hot dry season which lasts till the end of May. During the later part of the dry period, from early April onwards, midday temperatures normally rise well above 90° F., the land becomes increasingly parched, and rivers dwindle to a mere trickle. Working conditions during the hot weather proved extremely trying. Many writers have noted the debilitating effect of this season in Thailand, an effect from which the Japanese overseers seemed to suffer as much as did their labour force. Prof. Dudley Stamp states that "protection from the sun is always needed" there, but it is worth recording that most allied troops worked shirtless and often hatless in the open sun all day in this weather, yet cases of heatstroke were extremely rare.

Frequent sudden duststorms, culminating in squally torrential downpours, known to some as "mango showers" herald the wet season, which lasts from June to the end of October, though there is usually a fairly clear break of two or three weeks between the mango showers and the onset of the south west monsoon. In general the lowland tract does not receive heavy prolonged rain, and, though statistics are not available, personal observation leads to the conclusion that at Kanchanaburi the annual rainfall rarely exceeds 30″. Up country, in the plateau and mountain stretches three to four times this amount would appear to be common, and this heavier and more prolonged rainfall, combined with appreciably lower temperatures there gives rise to a simpler climatic regime, consisting of alternate wet and dry seasons, of approximately equal duration. Finally, the Burma sector, in general, since it lies on the windward side of the mountains, has a heavier rainfall than that of the Thai sector which represents, however, the greater part of the route.

As in the wider aspect of strategy, so in the more restricted matter of railway construction, monsoonal conditions imposed a marked rhythm on activity. During the period of rains, especially in the mountain regions, work became exceptionally difficult and progress slow, though the Japanese rarely called a halt on even the wettest days. More serious from their point of view was the volume of water in the Gwenoi which, during the late summer, rose to such an extent as to cause extensive flooding and often serious damage in the lower reaches. But by the end of the year the flow began to decrease perceptibly and from February or March till June (also the cholera period) river transport became increasingly hazardous, and in the upper stretches ceased altogether.

Thus the problem of organizing operations resolved itself into concentrating transportation of materials (by stream) so far as possible into the period from June to December, and doing the main

constructional work, especially bridging, during the dry season. Enormous quantities of bamboo, cut mainly in upper courses of the Gwenoi, were floated downstream in huge rafts to various base and construction camps in the wet season. It provided essential building material alike for camps, stations and store dumps and was in addition used for scores of lesser purposes. Traffic moving upstream in the same season consisted largely of rafts of local heavy timber to be used in bridge building and as ties, and barge-loads of rails, explosives, and occasionally primitive machinery, such as rudimentary pile-drivers.

Motor driven launches could tow up to a dozen such barges against the strong current, but it took them an average of five days to reach Lin Thin from Kanchanaburi. In addition, supplies of foodstuffs were also required for the labour gangs, but transportation of less bulky and more perishable commodities was not limited to any particular season. Various Thai and Chinese contractors were wont to bring barge-loads of food, mainly eggs and fruit, up the river to sell to the labourers. Prices rose steadily in proportion to distance upstream and also with advance of the dry season, though the continued depreciation of the tical, owing to Japanese currency manipulation, was a further complicating factor.

Little food could be obtained locally in the mountain area, which was very sparsely settled. Such cultivation as existed took place mainly on the eastern side of the river, but was on too small a scale to yield any appreciable surplus for the thousands of labourers employed in building the railway. Most of the cultivators were Thai squatters, who remained close to the river, which was patrolled by police launches, owing to the danger of gang robbers who plague remoter parts of the Siamese countryside. After two or three seasons in one locality the squatters would move up or down stream, clear another small patch of jungle, and cultivate it for a similar period. This shifting cultivation leads to extensive development of "secondary jungle," which is typical of the immediate vicinity of the river throughout the greater part of its length.

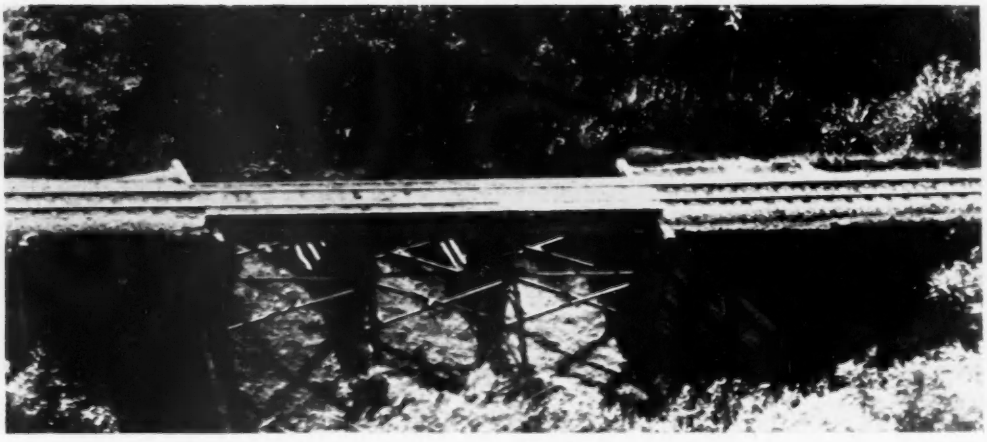

FIGURE 3.—Timber bridge across a gully. Photograph taken during the dry season. (Courtesy of the R. A. F. Crown Copyright Reserved.)

Population is thus unusually mobile, a characteristic which applies even to whole villages, though they are few and insignificant. The constant migration

tends to suggest a higher recent density of population than is actually the case. Otherwise it is difficult to explain W. A. Graham's statement, made in 1924, that the river flows "through a country containing ruins of ancient cities, and now occupied by prosperous communities of civilized Karien," a description which hardly holds true today. Many twentieth century maps also mark at least one town, called by a variety of names (usually spelling variations of Sangklabur) in the upper course of the Gwenoi, but the only approximation

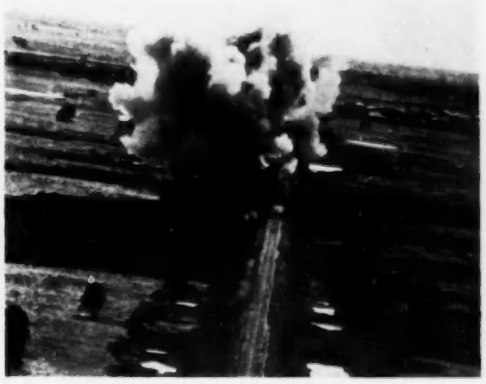

FIGURE 4.—Typical stretch of track in lowland country. The embankment, designed to raise the line above flood level, was constructed of earth dug from both sides, leaving holes which have filled with water during the rains. The photograph was taken during allied bombing operations. (Courtesy of the R. A. F. Crown Copyright Reserved.)

to anything of the kind today is the settlement, a few hundred strong, known to us as Tha Kanun village, a local market and minor administrative centre, dependent, before the railway was built, entirely on river communication. A small wolfram mine nearby was worked by a few Chinese.

In addition to the small indigenous population, a number of Bangkok and down-river Thais had, by 1942, found their way into the area, owing to the dislocations consequent on the Japanese occupation, and were engaged in operating river craft and cutting bamboo. The ubiquitous Chinese traders also ventured increasingly up the river after many of them had been expelled from so-called strategic areas elsewhere, as a security measure on the part of the Japanese. The west bank of the river remained practically uninhabited, though in the neighbourhood of Lin Thin and higher up occasional Burmese squatters managed to make a precarious livelihood. On the Burma side, the dense jungle country between the Taungnyo range and the Three Pagodas Pass appeared to be devoid of settlement.

Progress in construction of the railway proved to be extremely rapid, and its completion at the end of the monsoon in 1943 greatly surprised Allied Intelligence experts. In view of climatic considerations, the Japanese planned to start work in earnest immediately after the monsoon in 1942, rushing through as much of it as possible in the dry season, 1942–43, and finishing off, regardless of the rains, during the late summer, so as to be ready for all eventualities in the campaigning season of 1943–44. Such a plan involved assembling in advance necessary materials during the monsoon of 1942, and to that end big base camps of Ban Pong in Thailand, and Thanbyuzayat in Burma were built and occupied by pioneer parties, by June of that year.

Labour for the Siamese side consisted of British war prisoners interned on Singapore Island, who came up by train direct to Ban Pong, while Australian and Dutch prisoners were transported by sea from Singapore, Sumatra, and Java to Burma.

From the two base camps reconnaissance parties were sent out to site further labour camps along the route, and materials were then rushed up to them during the closing months of 1942. On the drier Siamese side railway con-

struction began almost at once, along the lowland stretch from Ban Pong to Kanchanaburi, and by early 1943 trains had already begun to operate on this section, thus enhancing the value of Kanchanaburi as a major collecting and distributing centre for the line.

The main working parties consisted principally of British, Australian, and Dutch troops as before. With the Australians were also a few Americans who had been captured in Java, began to arrive at close of the monsoon, in November 1942, and were distributed along the line at numerous points to enable the maximum number to work simultaneously. Large advance base camps were built in Kanchanaburi, Tamarkan—where work on the bridge across the Gweyai started immediately—Chungkai, and Tarsao on the Siamese side, as well as at various points in Burma, and "railway construction wardom" to use the high sounding official Japanese designation was well under way at all these points before Christmas. Officers as well as their troops had to work, usually on either bridge-building or communications (to erect telegraph poles and string wires) parties, which, though no less arduous than excavating and embanking, reputedly called for a higher level of intelligence, which may or may not have been forthcoming. As soon as a task had been completed by a group of workers, they marched up further along jungle tracks, and recommenced work at some higher point. In time new advance base camps were erected farther up, and so the work progressed.

In anticipation of the falling volume of water in the Gwenoi, the Japanese engineers decided to build a new road as an alternative means of transporting supplies from Kanchanaburi to Tarsao (Wanyai), which they later extended farther north. Considerable quantities of materials were transported by truck along this, especially during the later part of the dry season. Furthermore, such stretches of track as had been laid were put to immediate use, light diesel trucks, suitable for running on either road or rail, and capable of hauling half a dozen light flat bogie wagons, being employed even before the track was ballasted.

With speed and cheapness as the two predominating considerations in the minds of the Japanese, conditions of work remained throughout deplorable. The sickness and death rates mounted rapidly, owing to overwork, malnutrition, and an almost complete lack of sanitation and hygiene. Health services represented a luxury which, in Japanese eyes, the circumstances did not warrant. Such facilities as were available came entirely from the medically trained personnel among the prisoners, but in the virtual absence of drugs, bandages, adequate food, and rest, their value could only be limited.

Dysentery, avitaminosis, and finally cholera were the main direct causes of death, while the ever present malaria, which many persons had fifty or more times, and tropical ulcers, caused mainly through scratches from bamboo splinters, resulted in severe sapping of resistance and thus represented important contributory factors. While a certain proportion of casualties was unavoidable in such an undertaking, it is interesting to compare the relevant figures for this line with those of the Indo-China–Yunnan line constructed by French engineers between 1903 and 1910. The Yunnan railway, 290 miles in length, took some seven years in building, and out of a total labour force of 60,700, all Asiatic—mainly Chinese—some 12,000 died. The Thailand-Burma railway has a length of 245 miles, and was completed in less than a year. The exact

number of labourers employed is not known, but it it is estimated that 15,000 allied prisoners and 150,000 Asiatic coolies lost their lives, representing perhaps 30 per cent and 50 per cent respectively.

With an eye to their "Asia for the Asiatics" propaganda, and in expecta-

FIGURE 5.—Air photograph of mountainous jungle country on the route traversed by the railway. Note the incised meanders of the river, and settlement near its banks. (Courtesy of the R. A. F. Crown Copyright Reserved.)

tion of a heavy casualty rate, the Japanese began by using only allied prisoner of war labour, of which abundant supplies were then available. But the amount of sickness must have exceeded expectations and early in 1943 need for replacements became so acute that, in addition to fresh reinforcements of Dutch and British prisoners, enormous numbers of Asiatic coolies, consisting of Burmese and Indians on the Burma side, and Annamites, Javanese, Tamils from Malaya, and Chinese from various parts of South East Asia on the Thai side, were pressed into service. Partly attraction of promised high wages, and partly terrible food shortage in some areas, especially Malaya, led the unfortunate people to accept work on the railway, but in many cases further compulsion had to be resorted to in order to obtain the requisite numbers. Casualty figures for the Asiatics were much higher than the corresponding figures for Europeans, partly because of the lack of trained medical personnel, and partly also as a result of their ingrained mental habit of trusting their employers to look after their physical well being for them.

The Japanese attitude to labour, as to every aspect of the work, was based ultimately on considerations of short term economy. Of the three classical agents of production, land, labour, and capital, only labour is in good supply in Japan, and this has bred an attitude of mind which, by western standards, is extremely wasteful of the human factor. Since labour was equally abundant throughout most of the "Coprosperity Sphere" the same attitude continued to prevail there. It showed itself in numerous and surprising ways. Quite apart from the terrible wastage of lives, half or more of which could have been saved by relatively trifling expenditure on drugs and food, muscles replaced machines on all possible occasions. Pile drivers were worked by scores of men tugging on ropes, instead of by steam, and derailed locomotives replaced on the track by the same means. Similarly Japanese overseers were never content unless they had far more men on a job than was really required, or at least would be considered economical in the west. The main idea seemed always to employ the maximum number possible, as shown in the case of the 400 yard long Wampo viaduct, which was built in 17 days by some 2000 men.

The training and rank of the Japanese engineers again were amazingly low. An engineer lieutenant was in sole command of the building of over 50 miles of railway, and only two or three of his sergeants could understand the mechanical drawings involved in the work. Construction thus depended essentially on the use of rule of thumb methods, and in consequence much of it was extremely shoddy.

The same rigid economy also applied in respect to materials used, which were either locally produced or removed from existing installations elsewhere in the "Southern Regions." Thus all bridges were built of local timber apart from the big steel one at Tamarkan, which was transported thither from a militarily unimportant line in Java. The rails came from similar lines, notably the east coast line of Malaya, the northern half of which the Japanese had been unable to reopen after the extensive demolitions carried out there during the Malayan campaign (difficulties of communication between Singapore and N. E. Malaya may in part explain the handing back of the former Siamese provinces to Thailand, and on the Burma side from the Pegu-Toungoo line, which was reduced from double to single track. Ballast, by contrast came exclusively from local

sources, mainly cuttings along the line itself.

Finally locomotives and rolling stock could be drawn indiscriminately from all parts of the occupied territories, throughout which the metre gauge is normal. Siamese, Burmese, Malayan and Dutch East Indies locomotives and trucks were all seen in operation at one time or another, and some of the through troop trains from the east consisted of covered vans belonging to the Indo-China railways. Apart from light diesel trucks already mentioned, all locomotives were steam driven, and burned wood fuel. This, along with very bad maintenance and handling must have caused serious deterioration to most of them, as all except the Thai State Railways locomotives were designed to burn coal or briquettes, and did not function well on inferior fuel.

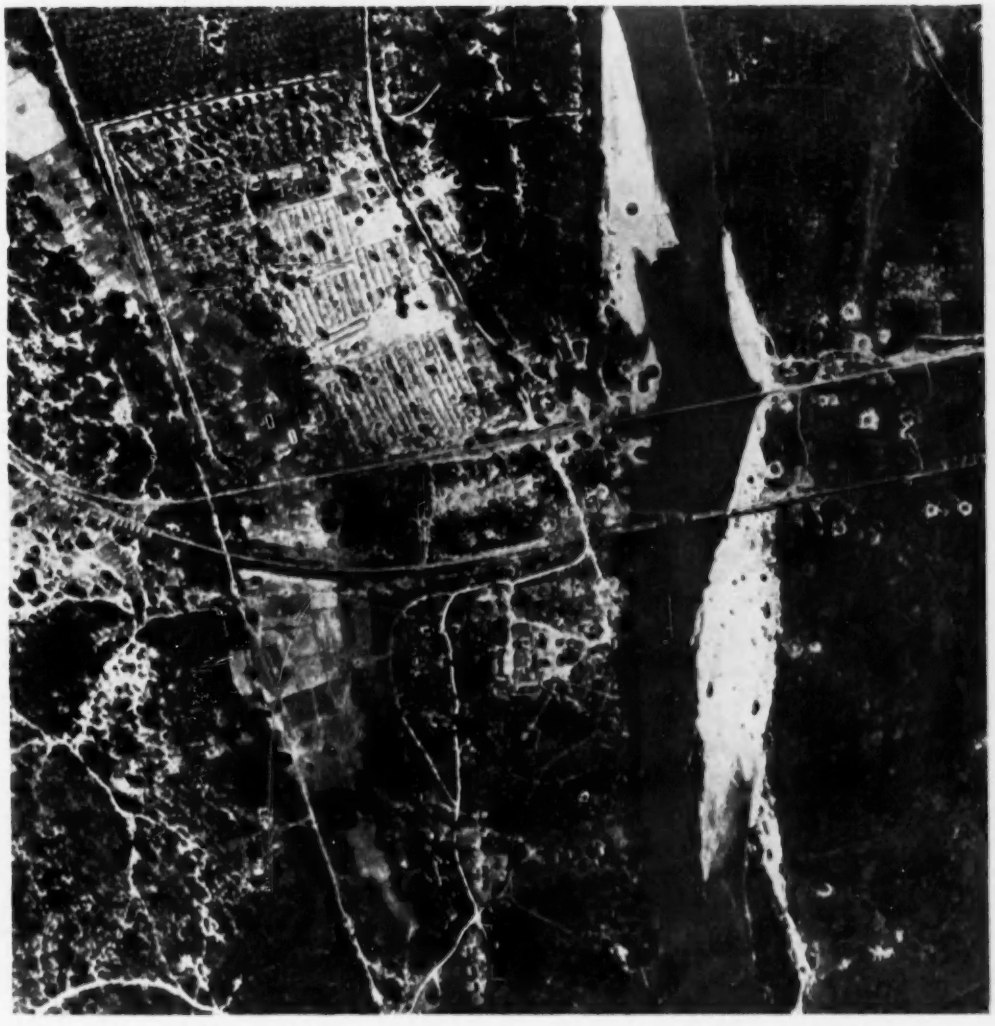

FIGURE 6.—The bombed bridge over the Gwei Yai at Tamarkan. The original steel bridge is on the left; to the right is a substitute wooden one. This photograph was taken during the dry season (1945); during the rains the river rises, covering the sandbanks, and rendering the wooden bridge very precarious. Tamarkan camp (right center) had been abandoned by this time, and the huts dismantled. Their pattern remains in the outline of the drains surrounding each long hut. (Courtesy of the R. A. F. Crown Copyright Reserved.)

Altogether, therefore, it can be seen that the line is an extremely makeshift affair. Though loops and sidings occur fairly frequently and repair and maintenance facilities were available at Nom Pladuk, Khai Sai Yok, and elsewhere, volume of traffic which the single line could bear was severely limited. Steep switch-back gradients are common throughout the mountain sector and these, as well as most of the exceedingly rickety bridges necessitated reductions in speed to four or five miles per hour. During 1944 I travelled by the line on numerous occasions, but never once at an average overall speed of more than about eight miles per hour.

Judged by western standards the railway hardly merits serious consideration as such and its construction represents application of short-sighted policies and false economies. Without complete overhaul it will inevitably fall to pieces in a very few years, while, if it is to bear traffic of a normal volume and speed, even by Siamese standards much of it, including nearly all the bridges, will have to be entirely rebuilt.

Yet in many ways it provides a valuable object lesson in Japanese methods, and it is impossible to deny that the available resources were used with great practical skill, and that, by and large, the line fulfilled the function for which it was intended. Despite all our forecasts to the contrary, the work was completed on October 17th, 1943, i.e. in slightly under one year, and thereafter carried a steady flow of troops and supplies to and from the Burma front. Supply ships from Japan delivered their goods straight into trucks at Bangkok, and these then ran direct to Moulmein via Ban Pong and the new line. Its cost to the Japanese must have been trifling, since all the more expensive materials were looted, and the prisoner of war labour would have required feeding whether it worked or not.

The future value of the line, however, apart from any strategic importance it may retain, is another matter. The recent sale, as a Japanese asset (despite the origin of materials and labour just noted), of the section passing through Thailand, to the Thai Government suggests that it is being taken more seriously than might have been expected.

So far as through traffic is concerned there appears little likelihood of any spectacular developments. Although there has always been a small trans-frontier trade, mainly in live animals and a little opium, via the old jungle tracks, the vast bulk of Siamese and Burmese exports consists in both cases of similar commodities, above all rice, which gravitate to Bangkok and Rangoon, and are competitive rather than complementary. If passenger traffic is to develop, heavy capital expenditure will be necessary to ensure possibility of reasonable speeds and safety, but whether this is a paying proposition, in view of existing air facilities is doubtful. On the other hand it has often been found that construction of a line creates such traffic on an unsuspected scale, and the case of the through line from Singapore to Bangkok may be cited as an example. The new line makes possible through running from Rangoon to both Bangkok and Singapore, and, given reasonable conditions of speed, might conceivably bear a fair volume of passenger traffic. The F.M.S.R. developed a lucrative tourist trade by encouraging ocean passengers to the Orient to disembark at Penang, travel overland via Kuala Lumpur, and rejoin their ship at Singapore, catching a fleeting glimpse of Malaya en route. Such tactics might well be extended to the new line whose landscape attrac-

tions far exceed anything to be found between Penang and Singapore.

As a rule, however, international railways rely less on through traffic than is generally assumed, and the trans-frontier link usually develops almost incidentally as the two rail networks on either side are gradually extended to their logical conclusion. In the case of the already mentioned Malayan-Thai line it is internal traffic in each of the two regions on opposite sides of the border which pays the main part of the bill, though a certain amount of livestock, and even rice, is regularly transported from Siam to Malaya this way, in preference to the normal sea route. (In addition there is the through passenger traffic mentioned above.)

From this point of view again the new line seems to have distinctly limited utility. Unless extensive engineering works make possible running of faster trains the line on the Thai side is little improvement on the traditional route provided by the Gwenoi, which seems adequate for the apparently limited resources and population of the region. Agriculturally the Western Mountain Fringe is one of the poorest parts of Thailand though the lower areas near Kanchanaburi, and the plateau country near Lin Thin may have certain limited possibilities and from a purely economic point of view many other areas offered much better prospects to the railway builder.

The one remaining possibility which might justify continued use of the line would appear to be discovery of important mineral wealth in the area through which it passes. Theoretically this, in common with the rest of Thailand, has been roughly surveyed, without disclosing anything of great value, but it must be admitted that such investigations, in view of prevailing conditions, could only have been extremely cursory. To even a superficial observer the similarity in geological structure of these mountains with the tin and wolfram bearing parts of Malaya and Peninsular Thailand is striking, and geologists among our numbers seemed favourably impressed with what little they saw. Existence of the small Chinese wolfram mine near Tha Kanun, and working of antimony farther north on the Burma side suggest that, now that a railway has been built, a detailed geological survey might prove remunerative. Already disquieting signs of exhaustion of many Malayan mining areas where before the war encouraging Malayan firms to examine the prospects of the more accessible portions of southern Thailand.

Depending in part on the attitude of the new Thai Government to foreign economic penetration, this process may now be extended into the area traversed by the new railway, and on the results achieved the future survival of the latter will probably depend. If it is to remain a permanent feature of the map extensive work must begin at once, or the jungle will soon engulf it. (Since the above was written one serious accident on the line has already been reported from Bangkok. On February 1st, 1947, a rail car plunged from a bridge into a ravine about 24 miles from the frontier. Two people were killed, one of them the Siamese Minister of Communications, and 19 seriously injured, including the director general of the Siamese railways and the director general of highways. They were members of an official party inspecting the newly acquired line.) Meanwhile its existence is one of the few remaining relics of the Japanese attempt to integrate the "Southern Regions," and its fragility and shoddiness form an apt commentary on methods employed to reach that end.

# THE POPULATION PROBLEM IN EGYPT

*L. James*

IT is rarely a simple matter to establish the optimum population level and the potential absorptive capacity of any region. Thus estimates for the total numbers that either Australia or Canada can eventually support vary from a few additional millions to hundreds of millions. It is commonplace to remark that capacity of any environment to support its population is related to its intrinsic resources and technical capacity of its population. Such a statement is obvious, yet when any attempt is made to discover more exactly in statistical terms, the optimum population of a given region the final results vary enormously according to the relative weight attached to particular factors, some of which are liable to unpredictable changes.

## I

In the case of simple communities like hunters and fisherfolk, or pastoral nomads, it is not so difficult to work out the optimum population a region can support. The optimum population is here defined as the level at which the resources of the environment are fully utilised under that particular form of economy, and further additions to the population would mean depression in existing standards, and any diminution in numbers would mean that environmental resources could not be fully utilised. In making this calculation allowance has to be made for abnormal circumstances such as liability to drought, etc. Calculation for self-sufficient agricultural communities is also straightforward, but it is more difficult to determine the optimum population level of the complex industrial regions and those areas having division of labour based on international commerce. Thus to take the simplest examples of the influence of price levels; in Egypt, the Anglo-Egyptian Sudan and Uganda, there is marked dependence on cotton as the one main cash crop. In all three territories it figures very highly in the export trade, and any serious fall in cotton prices is a serious catastrophe for large sections of the population of these units. Similarly Northern Rhodesia's economy is closely bound up with the world price of copper. The gold mining industry in South Africa and throughout the world owed its prosperity in the thirties to the departure from the gold standard after 1931.

In attempting to work out population adjustment in the more complex regions, it becomes necessary to estimate present and future trends in economic structure. Thus in the inevitable contractions and expansions that accompany economic change, the geographer has to enquire whether changes in effective demand for a commodity, say silk for example, are variations between times of depression and prosperity, or whether they are part of a long term contraction due to replacement of the commodity by some substitute or alternative product. It is at once apparent that the problematic character of the changing structure of price levels precludes finality being reached as far as statistical investigations are concerned into population adjustment. Quite obviously it is dynamic and not a static relationship, and new possibilities such as supplementing the already existing sources

of power by atomic energy mean a radically changed environmental basis for industry and therefore of society. A change of political frontiers can obviously affect optimum population level as they may involve industries being cut off from their previous market, or agriculture may come under a different system of control and policy. So too change in social structure alters absorptive capacity of a region as assuredly as irrigation facilities alter physical environment; a country with severe maldistribution of income may claim to have a population problem owing to large numbers living below the poverty line. With more equitable distribution of income and land, the whole complexion of the problem is changed. A geographer in studying human ecology has to take into account many factors other than the purely geographical, but this does not preclude an estimate being made of the degree of under or over population in any given region.

## II

The population of Egypt in 1800 was estimated to be nearly 2½ millions. With development of irrigation facilities in the 19th century, the population steadily increased, and in 1882 when the British occupation of Egypt began, the population amounted to 6.8 millions. Each of the census returns since 1897 shows a further increase, and at the 1937 census, the population totaled 15.9 millions, and is now estimated to be about 17¾ millions. One remarkable feature about the increase is that it has occurred in a population where debilitating diseases have an extremely high incidence. Thus three-quarters of the population suffers from effects of bilharzia and over half from worm diseases. Malaria, tuberculosis and venereal disease affect very large numbers. The death rate has gone up during the course of the present century, and infant mortality is higher than anywhere else in the Middle East.

The second feature about the increase in Egypt's population that calls for comment is that the basic economy of the country has remained agrarian in contrast with the situation in Europe where the increase in population has been accompanied by industrialisation. In Egypt despite increase in population, the actual area under cultivation has not been increased to anything like the same degree: in 1882 the cultivated area amounted to 4.7 million feddans (one feddan amounts to 1.038 acres), by the 1897 census it amounted to 5.0 million feddans and in 1937 it rose to 5.3 million. Owing to the great extension of perennial irrigation, the crop area has increased from 4.8 million feddans in 1882 to 8.3 million in 1937. As the population has increased at a much faster rate than either the cultivated area or the crop area, the fragmentation of holdings has proceeded rapidly over the last decades with all its attendant evils.

Study of the Egyptian peasantry is study of poverty with its concomitant illiteracy, prejudice and hopeless resignation. Housing, clothing and food are the minimum that will sustain life. Yet Egypt has a fertile soil in the Nile valley, and a climate that permits crops to be grown all through the year owing to the absence of a cold season. Water is the limiting factor since all cultivation is dependent upon irrigation from the Nile. Furthermore, Egypt has benefited economically from the two world wars, and although her territory was invaded in the second war, she suffered relatively little physical damage. The fact that the bulk of the population exists at a very low level indicates a state of population pressure, and doubts have been raised about

Egypt's capacity to absorb her steadily increasing numbers. Not all those who survey the Egyptian population situation are agreed however that a state of over-population exists, or is likely to exist in the next decades. Thus A. E. Crouchley in his economic survey arrives at the conclusion that there is a mal-distribution of population, but not a state of over-population. Yet E. B. Worthington in his survey of science in the Middle East concludes that Egypt has a population pressure "in some ways even more acute" than that of India. A. Bonné in his study of the economic development of the Middle East refers to the available land being "taken up to the utmost limit."

The crude figure of density per square mile, 45 in Egypt, means even less than usual because the greater part of Egypt is taken up by the Arabian and Libyan deserts: the cultivated land amounts to roughly 3½ per cent of the total. The means whereby Egypt can absorb her increasing numbers may be discussed under three heads: emigration, further industrialisation and increase in the agricultural production. The other possibility in the way of solving population pressure is to allow the standard of life to decline. This is not a serious alternative for a modern state, and we may assume that one of the three possibilities, or a combination of them will be the basis of future policy. The first possibility, emigration, is the least likely to be adopted. Although Egypt has close political relations with her Arab neighbours through the Arab League, emigration is unlikely to hold out any attraction to the fellahin. The remaining countries of the Middle East are under-populated, they are similar in sentiment i.e. religion and language, but it has been difficult to get the fellah to move to newly developed areas within Egypt; he is extremely conservative in outlook and quite clearly prefers the known to the unknown, however difficult the former seems. There is a lethargy that militates against migration.

## III

Prospects for further industrialisation are not unduly favourable. There are great advantages to be secured by any primary producing country from setting up secondary industries. The two world wars have tremendously increased Egypt's industrial plant, and in the inter-war period the government actively fostered the setting up of new industries by means of loans and protective tariffs. The actual industrialisation programme has largely been left to private enterprise and the Government has only become directly concerned in a few concerns like the Petroleum Refinery at Suez, doubtless because of its significance to defence arrangements. The Government has declared its intention of assisting the further industrialisation of the country. During the course of the second world war, Egypt's industries were greatly developed because the Middle East Supply Council set out to utilise local resources to the fullest possible extent in order to conserve shipping space. Normal economic factors such as the ability of locally produced goods to compete with those from abroad, were largely disregarded; the emphasis was on production and not on price. The only limiting factors to further production were difficulties of getting the necessary plant, the restrictions imposed by insufficient numbers of technicians and competent managers, and the availability of raw materials.

It was obvious that the end of the war would terminate the artificial economic atmosphere, and that normal trading conditions would necessitate the structure of Egyptian industry being re-planned in the light of world competition.

Such a readjustment is not easy. Egypt has no basic iron and steel industry although she has deposits of iron ore in the Aswan area and hopes in the future to establish an iron and steel industry. Egypt has no coal, but has alternative sources of power in oil and hydro-electric supplies. The production of oil from the Red Sea fields at Ras Garib, Gemsah and Hourgada has steadily increased (from .16 million tons in 1924 to 1.35 million tons in 1944). The original scheme at Aswan included the construction of a hydro-electric station which could supply power for about nine months in the year. The importance of such a station is that it could be combined with a plant to produce nitrogenous fertiliser. This commodity is extremely important for Egyptian agriculture; before 1939 Egypt normally imported some half million tons, but the need is now greater and is somewhere in the neighbourhood of ¾ million tons per year.

Egypt has limited quantities of other minerals besides oil and iron; Sinai has some manganese, and some 300,000 tons of phosphates are produced per year. Mineral production is capable of expansion, but it will not be sensational. From the viewpoint of further industrialisation. Egypt possesses advantage in having abundant and relatively cheap labour supply. Allied forces employed many thousands of Egyptians during the second world war and gave many of them elementary training. A further effect of this employment was to send up wage levels in Egypt. Although at the present time there is serious shortage of technical and managerial ability, there is little doubt that Egyptian workers can learn quickly the simple repetitive processes of modern manufacturing. That they possess relatively little in the way of special skills or industrial traditions is in considerable measure rendered less important by the routine nature of modern manufacturing processes. Greatest progress has been made in the field of textiles as might be expected in a land where cotton is the dominant crop. In 1938 out of the total imports valued at £.36.9, textiles made up seven millions and constituted the largest single item of imports; before 1939 the Egyptian mills absorbed only a small proportion of the total cotton grown in Egypt. Owing to the difficulty of importing textiles during the war, the proportion of the crop used in Egyptian mills greatly increased and the textile industry went some way towards meeting the home demands. Along with the much less important silk and woolen industries, the textile group employs over 100,000 of the industrial section of the community.

Before 1939, Egypt exported almost the whole of her cotton seed; with the war-time difficulty of getting vegetable oils, much greater quantities of cotton seed were utilised in the country for producing soap and other articles, as well as for making cotton seed cake for feeding cattle. In addition to expanding the older industries like textiles, chemicals, glassware, paints, etc., new industries were set up and new branches of older industries founded. The present problem is to adjust her industrial output to the level at which it can compete with foreign produced goods, or of continuing to shelter behind a protective tariff and thus increase the price of goods to consumers. There is natural reluctance to see infant industries extinguished by foreign competition. In the field where the greatest progress has been made, the textile group, Egypt faces the most severe competition from the older and longer established industries. There is the problem of obtaining new plant; at present the textile and other industries are using a good deal

of obsolete machinery. Although Egypt is holder of a large sterling balance, and doubtless a good deal of this will ultimately be employed to equip or re-equip Egypt's factories with modern plant, in the next years, Egypt, along with most other countries faces a shortage of capital equipment. One factor limiting further industrialisation is extremely low purchasing power of the great majority of the population. For those industries like soap and cement making, tobacco and leather manufacturing which have come to supply the whole or the greater part of the Egyptian market, expansion can only take place by developing an export trade, and Egypt's industries come into competition with more highly organised industries in other countries. Purchasing power throughout the Middle East is very low, but Egypt will doubtless become one of the manufacturing areas within the framework of the Arab League. On balance, prospects for further industrialisation in Egypt cannot be considered unduly favourable, and it is difficult to envisage more than 15 per cent of the population securing employment in industry.

At present there is much unemployment following the withdrawal of the Allied troops from the country. Revenue from the very large number of troops in Egypt during the years of the second world war was considerable, and was one factor encouraging inflation. The departure of British troops means further unemployment and a reduced revenue from the troops themselves. In the future Egypt can hope for return of the tourist industry, and thus increase her invisible exports.

## IV

Basically Egypt can only solve her population problem by increasing her agricultural production. This involves increasing the production of land already under cultivation and secondly, of increasing the amount of cultivated land. There are clear limits to what can be accomplished in the two fields. The application of research to crop yield can increase amount of foodstuffs and cotton; already improvement of the seeds used in maize cultivation has increased yield of this crop, and the Karnak variety of cotton gives a high yield for this kind of staple. Already however the cultivated land of Egypt is made to produce more than any other in the world because the Egyptian fellah is a gardener rather than a farmer and the main hope of increased crops lies in converting the remaining sixth of Egypt's cultivated land from basin system of irrigation to perennial irrigation. Already five-sixths of Egypt's 5.3 million feddans are cultivated under the perennial system, and this means that crop production can continue throughout the year. There is no temperature check to plant growth, and cultivation is solely a question of water supply. By means of the dams and canals of perennial irrigation, water can be brought to five-sixths of Egypt's cultivated land throughout the year. In the remaining sixth, mainly in Upper Egypt, the old basin system is still used, and this means that only one crop is obtained because water is not available in spring and early summer. The crop is planted in the moistened soil after the Nile floods of the late summer, and harvested in the following spring. The conversion of land under basin irrigation to perennial irrigation is going ahead steadily and will increase crop area by making this million feddan produce crops throughout the year.

The second means of increasing agricultural production is by securing an additional acreage. Only one-twenty-eighth of Egypt's total area is cultivated owing to the water problem; the cen-

turies have not lessened Egypt's dependence on the Nile; it is estimated that an additional 1¼ million feddans can be cultivated if more water is made available. This involves land reclamation and constructing major irrigation works further up the Nile Valley. There is also the problem in Egypt of dealing with the flood waters when they are exceptionally high and one possibility of dealing with the problem is by increasing the height of Aswan dam.

It is the need for more water to irrigate more land that underlies Egypt's persistent emphasis on the "Unity of the Nile Valley." Egyptian thinking is always closely related to the water problem because of her absolute dependence on the water from the Nile. Bringing more water to Egypt means that work will have to be undertaken in the Sudan, or in Ethiopia or in Uganda, and the schemes that have been periodically examined are (1) construction of a dam at the outlet of Lake Tana in Ethiopia, so that the water of the Blue Nile can be regulated to bring more water to Egypt in the critical months of early summer, (2) cutting of a canal in the sudd region of the Bahr-el-Jebel stretch of the Nile to lessen the present high rate of evaporation and seepage, and (3) the building of a reservoir at Lake Albert or lower down the river at Nimule.

Such schemes will be very costly to carry out, and in the case of the Sudan involve careful analysis of the area's future needs. Her Gezira scheme has shown what can be accomplished given the technical assistance and the necessary finances, and the Sudan is only on the threshold of economic development. Egypt's main fear is that the Sudan might become a competitor for the Nile water at the same time that Egypt herself is in need of greater supplies to enable her to tackle her problems arising from pressure of population in her very limited area of cultivated land. In the past Egypt has been the most populous and most advanced of Nile valley political units, but the development of the Sudan and Uganda will mean a much greater concern for the Nile water as their economic development proceeds.

One means of increasing agricultural productivity in Egypt that awaits full investigation is dry farming. The Government has maintained experimental stations as at Bourg el Arab to endeavour to demonstrate the possibilities of growing olives, figs, dates, etc., in the drier areas by means of tapping the underground supplies of water. The northern littoral of Egypt was once an important granary of the Mediterranean world, and dry farming could contribute to making it an important fruit producing area.

During war years, Egypt's one crop economy based on cotton was by force of circumstances diversified. Efforts were made to grow crops like flax, but inexperienced processing made the product of low quality. One of the problems in Egypt's agriculture lies in the lethargic character of the fellahin; new crops and improvements require the coöperation of an alert and literate peasantry, and Egypt is a very long way from this stage. If Egypt is to absorb her growing population at a reasonable standard of life, she must undertake construction of one or more of the schemes farther up the Nile to ensure more water for her land. The main economic basis of Egypt will remain agricultural, and although wartime tendency to diversify her crops is tending to disappear, efforts ought to be made to develop a cattle and stock industry.

Along with technical improvements in agriculture, there is urgent need for social and political measures to improve

the lot of Egypt's peasantry, who make up four-fifths of the total population. Land reform becomes ever more urgent; the system of having the largest part of the land owned by a relatively small number of landlords means that the fellahin are paying away annually the greater part of their cash income (from their cotton crop) to the landowners. Increases in price of cotton have been quickly followed by an increase in land rents, and the Government has only intervened in times of exceptional distress. Along with further industrialisation, and increase in the water supply to cultivate the additional 1¼ million acres, ought to go a radical measure of reform in the distribution of land. If energetic measures are not taken over the next years, Egypt will "solve" her problem of population pressure by allowing the already low standard of life for the vast majority of the population, to decline further. This is a catastrophe that ought to be avoided by every means at the disposal of a state that seeks to be included among the progressive and the enlightened.

# IRON AND STEEL INDUSTRY IN JAPAN

*Muzaffer Erselcuk*

WHILE Japan does not rank with the great steel-producing nations of the world, its position has steadily gained in importance during the first forty years of the twentieth century. By the time of the outbreak of World War II Japan occupied the sixth place in the making of steel.

## Introduction

In any discussion of the Japanese iron and steel industry, it is necessary to understand some of its peculiarities. First of all, the industry is now practically idle—not because its large capacity has been destroyed or damaged as a result of hostilities, but because it is cut off from essential supplies of coal and iron. Second, the Japanese iron and steel industry has had to import iron and coal; national deficiency in the essential materials has proved a severe handicap, for both are bulky and transportation adds greatly to their cost. Third, the Japanese iron and steel industry having been mainly designed for national defense, its present capacity far exceeds current peacetime needs.

This paper is concerned with iron and steel industries of Japan proper and will exclude extensive developments by the Japanese in various parts of Eastern Asia. The object of the study is (1) to trace the rapid development of the Japanese iron and steel industry, and (2) to evaluate the basis for an iron and steel industry in Japan in an attempt to forecast its possible position in the near future.

## Historical Outline

Japanese records indicate that as early as the seventh century A.D. iron was extracted from magnetic sands of the country. Improvements in technology soon led to manufacture of high-grade swords. About a millennium later, it was reported in 1671 that iron was being smelted at 267 places in the Japanese islands.

After the doors of Japan were opened to the Westerners during the middle of the nineteenth century, the government, realizing the importance of iron to national strength, tried to promote the industry by direct government management. The first experiment in 1874, failed. A bill introduced into the Diet in 1896 for a second experiment was defeated. The war with China (1894–95) demonstrated the importance of iron, and popular sentiment in behalf of establishing an iron and steel industry at any cost was so strong that the Diet in 1896 appropriated funds with which the government established the Imperial Steel Works at Yawata, the nucleus of the present Japanese steel industry. The construction of a 90,000-ton capacity steel mill was completed in 1901, five years later.

The Yawata Works proved invaluable during the Russo-Japanese war of 1904–5, and the government decided on expansion. Their annual production capacity was increased to 180,000 tons by 1909 and to 350,000 by 1916. World War I induced the government to increase capacity further, to 750,000 tons.

Although during 1900–1913 several private firms began to expand their facilities, the main stimulus to a non-governmental steel industry was provided by World War I. In 1915 there were six private corporations engaged in the steel industry, and by the end of

1918 their number had reached 43, each with an annual ingot steel capacity of 5,000 tons or over.

At the end of the war when steel prices fell, many private steel enterprises suspended operation and others restricted activities. In spite of the elimination of marginal firms, a steady rate of increase in production was maintained until 1943. (See Table I.) It is true that the expansion was checked for a very brief period in 1931 and 1932, but it was resumed more rapidly than ever after 1933.

Between 1933–45 striking developments were evinced in the Japanese-controlled iron and steel industries of the Far East, among which can be listed the following:

1. Discovery of large iron-ore deposits, both in the Japanese Empire and in the Japanese-occupied lands.
2. Development of technology for utilizing low-grade iron deposits.
3. Modernization of existing equipment and building of new production facilities.

They were not result of haphazard developments by private enterprise, but of methodical planning of the Japanese Government, which wanted to insure for national defense, adequate and correlated iron and steel facilities.

The goal was achieved in two successive stages, which grew out of the government's usual method of protecting the iron and steel industry by means of subsidies and tax exemptions.

The first stage, aimed at indirect control, was the merger in 1934 of the Government Iron and Steel Works with the three leading pig iron producers, which resulted in the formation of Japan Iron Manufacturing Co., (Nippon Seitetsu), in which the Government held controlling interest. (The capital of the Japan Iron Mfg. Co. was 359,821,000 yen at the time of its formation, with the Government share representing 284,195,000 yen.) Plants of the new company produced in 1934 96 per cent of the total Japanese production of pig

TABLE I

JAPANESE PIG IRON AND STEEL PRODUCTION, SELECTED YEARS

(IN METRIC TONS)

| *Year* | *Pig Iron* | *Steel* | | | *Total* |
|---|---|---|---|---|---|
| | | *Open Hearth* | *Bessemer* | *Electric* | |
| 1896 | 26,000 | ..... | ..... | ..... | 1,000 |
| 1913 | 243,000 | ..... | ..... | ..... | 255,000 |
| 1918 | 583,000 | 798,000 | ..... | 4,300 | 813,000 |
| 1922 | 551,000 | 807,000 | ..... | 4,000 | 909,000 |
| 1926 | 810,000 | 1,401,000 | ..... | 18,000 | 1,506,000 |
| 1930 | 1,162,000 | 2,225,000 | ..... | 62,000 | 2,289,000 |
| 1932 | 1,011,000 | 2,325,000 | ..... | 70,000 | 2,398,000 |
| 1934 | 1,728,000 | 3,634,000 | ..... | 209,000 | 3,844,000 |
| 1935 | 1,865,000 | 4,460,000 | ..... | 242,000 | 4,703,000 |
| 1936 | 1,972,000 | 4,901,000 | ..... | 316,000 | 5,217,000 |
| 1937 | 2,252,000 | 5,363,000 | ..... | 435,000 | 5,798,000 |
| 1938 | 2,467,000 | 5,646,000 | 59,000 | 756,000 | 6,461,000 |
| 1939 | 3,068,000 | 5,653,000 | 152,000 | 888,000 | 6,693,000 |
| 1940 | 3,417,000 | 5,539,000 | 233,000 | 1,083,000 | 6,855,000 |
| 1941 | 4,088,000 | 5,283,000 | 333,000 | 1,221,000 | 6,837,000 |
| 1942 | 4,306,000 | 5,327,000 | 352,000 | 1,420,000 | 7,099,000 |
| 1943 | 3,813,000 | 5,558,000 | 331,000 | 1,932,000 | 7,821,000 |
| 1944 | 2,713,000 | 3,855,000 | 197,000 | 1,859,000 | 5,911,000 |
| 1945 | 1,145,000 | 610,000 | ..... | 455,000 | 1,065,000 |
| 1946 | 132,000 | ..... | ..... | ..... | 565,000 |

Source: Compiled from Statistics of Japanese Bureau of Mines and data supplied from Iron and Steel Control Association.

iron, 53 per cent of the steel ingots, and 44 per cent of the finished steel.

The second stage came at the end of 1936, when a five-year plan for iron and steel production was adopted. It was necessitated by rapid increase in steel production, result of imported pig iron and scrap, by companies outside the merger; however, there was no corresponding rapid increase in the domestic blase furnace operations. According to the Plan, the Japanese Empire and Manchuria were to produce 6 million tons of pig iron in 1941. In 1937, a new scheme was announced for increasing pig iron production to 8 million tons by 1941. (Of this amount 5,600,000 tons were to be produced in the Japanese Empire and 2,400,000 tons in Manchuria).

After outbreak of hostilities between China and Japan in 1937, the Iron Manufacturing Industry Law was introduced, making it compulsory for all iron manufacturing concerns to ask governmental permission to make any changes in their expansion and operation program. The government could order necessary changes needed by the again revised program, now the so-called Four-Year Plan, announced in March, 1938. At the same time the Iron and Steel Control Council, consisting of government officials and representatives of the iron manufacturers and the principal consumers, was organized. The council was to plan for the future production and distribution of iron and steel products. The Four-Year Plan contemplated 12,500,000 tons of pig iron capacity at the end of 1941. (Manchuria, because of the changed schedule, had to revise its Five-Year Plan goal for 1942 upward in April, 1938, from 2,400,000 to 4,783,000 tons of pig iron.) Toward the end of 1938 the Four-Year Plan was revised by the Japanese Planning Board, and a new Four-Year Plan, which included the Japanese Empire, Manchuria and North China, was formulated. Under the new plan, iron ore production was to increase 250 per cent over 1938 production by 1942, and pig iron by 200 per cent, steel capacity by 160 per cent and alloy steel capacity by 200 per cent. Figures for the base year, 1938, however, were not made public.

It was not possible to complete the Four-Year Plan on schedule, because of the war-imposed strain on the Japanese economy. Although a large number of plants were built, shortage of raw materials kept them from operating.

## RAW MATERIALS

Steel is made from iron ore through the intermediate production of pig iron. In the Far East, four to five tons of materials are needed to produce one ton of pig iron, depending on the iron content of the ores. The mining and transportation of the raw materials represent the first stage of a steel industry, and the production of pig iron represents the second stage. Pig iron, scrap, carbon, small quantities of manganese and possibly ferroalloys are melted together to make steel; in the final, or fourth stage, ingot steel becomes finished steel by casting, forging, or rolling.

In operation of blast furnaces or rotary kilns, the ore supplies the iron, the coke or coal is the source of heat and carbon, and the means of reducing iron oxide to metallic iron, and limestone combines with such impurities as silica, aluminum and acid materials to form slag. Foundries require iron ores that can be handled easily and economically in the blast furnaces and coal that can be made into strong coke. Neither Japan nor areas in the immediate vicinity of Japan are so far known to possess large, accessible, and economi-

cal deposits of either coking coal or iron, especially of the latter.

## IRON ORE

Iron ores of the Far East are either low in iron and found in small deposits, or present technological difficulties in smelting. The known high percentage iron ores are widely scattered, and their small size and distance from coking coal deposits makes them of limited value (with a few exceptions) for creation of reduction facilities in their vicinity. Therefore, under prevailing economic and technological conditions prior to the present war, an iron and steel were produced only in parts of eastern Asia where the state provided suitable financial protection. Japan and Soviet Russia were the only countries that could afford such protection; and as a result the iron and steel industry developed in Russian Far East and in Japanese-occupied lands but not in the rest of the Far East.

Lands accessible to Japan during the war have about 7.2 billion tons of known deposits of iron ore, containing about 3.1 billion tons of metal, of which only about 5 per cent is located in the Japanese Islands. Distribution of ore reserves according to various regions is shown in Table II.

Extensive though the reserves may at first appear from Table II, closer examination will reveal that Japan proper, where the bulk of the smelting facilities are located, has small deposits. If the blast furnaces and other reduction units in Japan proper were to depend solely on domestic iron ores and sands, at the 1936 annual consumption rate of 3 million tons of metallic iron, known reserves would be exhausted in 50 years; at the Four-Year Plan's rate of 6 million tons the deposits would have lasted only 25 years. Japanese political leaders, as well as Japanese businessmen, quite aware of the situation, took several peacetime steps to conserve iron resources. Among these may be listed:

1. The domestic iron ore deposits were exploited only to a limited extent; thus in 1936, of the known 75 deposits, about 60 were in a state of conservation. In the same year the domestic ore output corresponded to 363,000 tons of metallic iron, whereas imports were 2,415,000 tons.
2. In order to save fuel, as well as iron ore, Japanese industry made considerable use of scrap iron in the manufacture of steel. Scrap imports totalled 489,000 tons in 1930, 1,013,000 tons in 1933, 1,692,000 tons in 1935, 2,420,000 tons in 1937 and 2,555,000 tons in 1939.
3. The metallurgical policy of the government called for creation of a national stockpile. The reserve, amounting to the equivalent of 1,100,000 tons of metallic iron in 1931, increased to 2,500,000 tons in 1936, and was about 2,200,000 tons at the beginning of 1941. In addition to the iron ore stockpiles a considerable amount of scrap steel was put aside for emergency use. (See Table III.)

TABLE II

UTILIZABLE IRON RESERVES IN FORMERLY JAPANESE CONTROLLED AREAS OF THE EASTERN ASIA

(IN METRIC TONS)

| | *Ore Reserves* | *Metallic Iron* |
|---|---|---|
| Japan proper | 415,000,000 | 157,000,000 |
| Korea | 1,100,000,000 | 360,000,000 |
| Formosa | 10,000,000 | 5,000,000 |
| Manchuria | 3,100,000,000 | 1,290,000,000 |
| Northern China | 225,000,000 | 127,000,000 |
| Central China | 100,000,000 | 50,000,000 |
| Southern China and Hainan | 15,000,000 | 8,000,000 |
| Indo-China | 68,000,000 | 35,000,000 |
| Malaya and Siam | 50,000,000 | 30,000,000 |
| North Borneo | 25,000,000 | 14,000,000 |
| Dutch East Indies | 1,050,000,000 | 521,000,000 |
| Philippine Islands | 1,010,000,000 | 476,000,000 |
| Total | 7,168,000,000 | 3,093,000,000 |

Source: The above figures are obtained by adding the reserves of the individual known deposits in the particular areas. Since various types of ores vary greatly in iron content, in order to establish a uniform basis of comparison, metal content of the ores will be used as a unit. One "metal content" is equal to one ton of pig iron by definition adopted in this paper.

Of 157 million tons of metallic iron given as total reserve for Japan proper, 58 million tons are contact metasomatic and chemical precipitation deposits, 59 million iron sands, 9 million iron pyrites, and 31 million nickeliferous iron deposits. (See Map I and Table IV.)

TABLE III

STOCKPILES OF IRON ORE AND SCRAP IN JAPAN PROPER, 1935–1944

(IN THOUSANDS OF METRIC TONS)

| End of Period | Scrap | | Iron Ore | |
|---|---|---|---|---|
| | Stockpile | Net Addition | Stockpile | Net Addition |
| 1931 | 1,389 | ..... | ..... | ..... |
| 1932 | 1,806 | 417 | ..... | ..... |
| 1933 | 2,492 | 686 | ..... | ..... |
| 1934 | 3,036 | 544 | ..... | ..... |
| 1935 | 3,387 | 351 | 3,195,000 | ..... |
| 1936 | 3,489 | 102 | 4,362,000 | 1,167,000 |
| 1937 | 4,509 | 1,020 | 4,151,000 | − 211,000 |
| 1938 | 4,821 | 312 | 4,228,000 | 77,000 |
| 1939 | 5,791 | 970 | 3,952,000 | − 276,000 |
| 1940 | 5,712 | − 79 | 3,812,000 | − 140,000 |
| 1941 | 4,468 | −1,244 | 2,605,000 | −1,207,000 |
| 1942 | 3,099 | −1,369 | 1,399,000 | −1,206,000 |
| 1943 | 1,437 | −1,662 | 792,000 | − 607,000 |
| 1944 | 449 | − 988 | 672,000 | − 120,000 |

Source: Compiled from data supplied by The U. S. Strategic Bombing Survey, *The Effects of Strategic Bombing on Japan's War Economy*, Appendix Tables C-18 and C-20.

The Japanese iron reserves are relatively insignificant in comparison with those of other iron and steel producing countries. For instance, the United States is credited with high-grade deposits of 1.9 billion tons and 20.5 billion tons of lower grades, and France and England have reserves of 4 billion and 14 billion respectively of both rich and poor iron ores according to figures for the U. S. obtained from data given by Charles Parker, *Steel in Action*, 1943, pp. 94–95 and also from the United States Tariff Commission, *Iron and Steel*, 1946, p. 78. The figures for France and England are from *Statistisches Jahrbuch fur die Eisen und Stahlindustrie* for 1937. All of the above figures are in terms of metal content.

Most of the iron ore produced between 1925 and 1945 in Japan proper was obtained from the Kamaishi Mine in Iwate and the Kutchan Mine in Hokkaido. In this period, with exception of 1944, combined annual output of the mines exceeded the annual total produced by all other mines; and from 1925 to 1938 their average annual production was about ten times that of other mines. The Kamaishi mine has produced more than 300,000 tons of magnetite per year between 1935 and 1944. The ore body at Kamaishi is about 3 miles long and 1 mile wide. Available reserves now amount to 42 million tons, 12 million of which are of 50–60 per cent and the remainder below 40 per cent and high in silica. Kutchan mine is one of the more important bog iron beds scattered about Iburi county of Hokkaido. The beds of limonite are 6–15 feet in thickness, and are of very high moisture content.

Iron mines other than Kamaishi and Iburi deposits are generally considered submarginal and most of them were brought into production by means of subsidy payments during 1938–1945. Inadequate reserves, badly mixed grades of ore, location in mountainous terrain with associated transportation difficulties are factors responsible for high cost of production. It was cheaper to import, even from such distances as Malaya, than to mine the majority of domestic deposits.

Besides regular iron ore deposits, Japan has considerably larger deposits

of iron sands. The beach of an ancient ocean, elevated by tectonic movement, yields the deposits. Iron sands were formed from disintegration and erosion of granite, diorite and basic volcanic rocks by water. Iron sands derived from diorite and volcanic rocks are mixed with titanium, and their quality is inferior to that from granite. Titanium is objectionable because it makes the ore refractory and derives much of the iron into the slag.

The most important of the iron sand deposits is located at Kuji in Iwate, where iron sand deposits lie within 6 miles of the sea, at elevations from 500 to 1,000 feet, and extend for about 15 miles along the foot of the higher hills. The greatest known width is about 4,000 feet and the average depth of minable ore is about 10 feet, though in places the sands carry a substantial amount of iron to depths of 75 feet. The beds are 10–30 feet below the sur-

TABLE IV

IRON DEPOSITS OF JAPAN

| *Deposit* | *Location* | *Ore Reserves (In Metric Tons)* | *Iron Content (Per Cent)* |
|---|---|---|---|
| *Contact Metasomatic Deposits* | | | |
| Magnetite | | | |
| 1. Kamaishi, Rich ore | Iwate | 12,000,000 | 50–60 |
| Poor ore | Iwate | 30,000,000 | 30–40 |
| 2. Ishizuchi | Ehime | 10,000,000 | 30–40 |
| 3. Nakakosaka | Gunma | 500,000 | 50–55 |
| 4. Ishikawa | Fukushima | 1,200,000 | 45–50 |
| Hematite | | | |
| 5. Akatani | Niigata | 3,000,000 | 45–60 |
| 6. Awagadake | Niigata | 1,000,000 | 50–60 |
| 7. Akimachi | Kochi | 2,000,000 | 30 |
| 8. Matsuo, Morioka | Iwate | 1,000,000 | 30–50 |
| 9. Futochonmai | Hokkaido | 600,000 | 30–40 |
| 10. Yahagi | Iwate | 600,000 | 35–53 |
| 11. Sennin | Iwate | 600,000 | 50–55 |
| Unclassified | | | |
| 12. | Toyama | | 38–50 |
| *Chemical Precipitation Deposits* | | | |
| Limonite | | | |
| 13. Abuta | Hokkaido | 6,700,000 | 35–55 |
| 14. Kutchan | Hokkaido | 4,000,000 | 45–53 |
| 15. Horomoe | Hokkaido | 1,500,000 | 40–50 |
| 16. Tokushumbetsu | Hokkaido | 700,000 | 35–50 |
| 17. Nakadoya | Hokkaido | 500,000 | 35–50 |
| 18. Sorachi | Hokkaido | 300,000 | 40–45 |
| *Detrital Deposits* | | | |
| Iron Sands (Limonite and Magnetite) | | | |
| 19. Kuji | Iwate | 150,000,000 | 30–40 |
| 20. Tanegashima Isl. | Kogoshima | 20,000,000 | 30–35 |
| 21. Hiroshima–Shimane–Tottori | Chugoku | 20,000,000 | 30–35 |
| 22. Funkawan | Hokkaido | 1,000,000 | 30–35 |
| 23. Naarai | Chiba | 500,000 | 30–35 |
| *Iron Pyrite Deposits* | | | |
| 24. Yanahara | Okayama | 4,500,000 | |
| 25. Matsuo | Iwate | 2,500,000 | |
| 26. Besshi | Ehime | 2,000,000 | |
| 27. Hitachi | Ibaraki | 1,000,000 | |
| 28. Takara | Yamanashi | 500,000 | |
| 29. | Yamagata | | |
| *Nickeliferous Iron Deposits* | | | |
| 30. Wakasa | Fukui | 49,300,000 | 36 |
| 31. Ryuten | Okayama | 35,000,000 | 20–30 |
| 32. Oyeyama | Kyoto | 6,600,000 | 25–30 |
| 33. Kamogawa | Chiba | 2,000,000 | |
| 34. Miyagawa, Miwa, Shizuke | Nagano | 2,000,000 | |
| 35. Hakusan | Oita | 1,500,000 | |

face, therefore suitable to open cut methods of mining. (A detailed description of Kuji iron sand deposits is given by James W. Neill "Making Iron From Beach Sands in Japan," *Engineering and Mining Journal*, February 5, 1927, pp. 243–245.) The sands contain magnetite and limonite particles and iron content ranges from 23 per cent to 60 per cent iron. Magnetite carries about 14 per cent and limonite about 2.5 per cent titanium dioxide. The deposits also carry about 0.2 per cent vanadium and a still smaller amount of gold.

Other deposits of iron sands are found at Funkawan in Hokkaido; Naarai in Chiba Prefecture, northeast of Tokyo; at Tanegashima Island of Kogoshima Prefecture, southern Kyushu; and in a large area extending from the northern part of the Hiroshima Prefecture into the Prefectures of Shimane and Tottori (see Map II). All above listed iron sand deposits have been utilized during the war by methods varying from mechanical digging to hand picking of metal lumps by women and children. For modern practice the deposits present two technical problems—concentration of the ore and elimination of titanium—which have not yet been satisfactorily solved. The 1944 production of iron sand was estimated to be about 378,000 tons of 60 per cent concentrates.

FIGURE 1.—Iron Mines in Japan. Of the many known iron deposits of Japan, about 75 in number, the Kamaishi Mine in Iwate and the Kutchan Mine in Hokkaido have exceeded in production the annual total of all other mines; from 1925 to 1938 their average annual production was about ten times that of other mines. The Kamaishi Mine in which the ore body is about three miles long and one mile wide, produced more than 300,000 tons of magnetite per year between 1935 and 1944; and its available reserves now amount to 42 million tons, 12 million of which are high grade, and the remainder low grade and high in silica. Kutchan Mine is one of the more important bog iron beds scattered about Iburi County of Hokkaido.

Application of the Steurzilberg process to the residue of pyrites after sulphuric acid has been extracted yields iron suitable for blast and rotary furnace use. Pyrite deposits are scattered over the main island of Honshu. Of the 15 iron pyrite mines in Japan, five produce over 75 per cent of the iron pyrites. They are Yanahara mine in Okayama, Matsuo mine in Iwate, Besshi mine in Ehime, Hitachi mine in Ibaraki and Takara mine in Yamanashi. Their deliveries of pyrite sinters amounted to 703,000 tons in 1943 and 340,000 tons in 1944, reduced by U. S. bombing.

From 1937 to 1945, the Japanese mined submarginal nickeliferous iron ore to alleviate shortage of nickel. Ores used were nickel-bearing serpentine and residual clays derived from serpentine. The ores contained 0.3–0.6 per cent nickel and 20–36 per cent iron. Clay deposits contained higher percentages of nickel and iron than serpentine. The ore was converted in rotary kilns to nickel-bearing pig iron containing 2 per cent nickel which in turn was fabricated into nickel alloy steel in electric furnaces. About 95 per cent of the ore came from 5 mines.

The largest known ore reserves are located at Oyeyama in the northern

part of Kyoto Prefecture: Wakasa, in Fukui Prefecture on a small peninsula projecting into the Sea of Japan; and Ryuten, in Okayama. Each one of the deposits contains more than six million tons of ore. Other sizable reserves are located at Kamogawa, Chiba Prefecture; Urakawa, Shizuoka Prefecture; Omukai, Yamaguchi Prefecture; Hakusan, Oita Prefecture; and Miyagawa, Shizuke,

FIGURE 2.—Iron Sand Deposits in Japan. The most important of the iron sand deposits is located at Kuji in Iwate at elevations from 500 to 1000 and within six miles of the sea. The deposit is fifteen miles in length, with a widest section of 4000 feet, and average depth of minable ore about 10 feet; the beds are 10–30 feet below the surface permitting strip-mining.

and Miwa, all in Nagano Prefecture. Production of nickeliferous ores is shown in Table V.

Recovery of iron and nickel from serpentine and clays was expensive and continued only so long as the Japanese government subsidized production. At present none of the mines is worked.

It is evident that iron deposits of Japan proper are entirely inadequate for maintenance of large-scale iron and steel industry. Since there is little likelihood that any large additional reserves will be discovered in the Japanese islands in the near future, necessity, as in the past, will force the Japanese to look elsewhere for iron.

Japan has always imported large amounts of iron ore, pig iron and iron scrap. Although distances the iron ores had to travel were great, cheap water transportation made inexpensive shipments possible. Cost of high grade iron ore delivered from Malaya or the Philippines was less than that of most ore produced within Japan; (Statement by Foster Bain in the *Trans-Pacific*, Tokyo, August 12, 1947) therefore, peacetime domestic production of iron ores was small and Japan relied heavily on foreign ores (as seen from Table VI). In spite of substantial increase in domestic iron production during the war, foreign ores provided more than half the ore needs of Japanese blast furnaces until 1943. Iron ore source of supply during 1936–1945 in terms of percentages was as follows:

| | |
|---|---|
| China | 30.2% |
| Malaya | 22.1% |
| Philippines | 8.2% |
| Home Production | 26.1% |
| Korea | 7.5% |
| Manchuria | .5% |
| Other imports | 5.9% |

Prior to 1914, Japan obtained over 90 per cent of her imports of iron ore from China. During the twenties and thirties British Malaya, Korea and the Philippines had become important sources of supply. Shortage of shipping prevented importation of iron from Malaya and the Philippines during 1941–1944. To offset the situation the Japanese increased domestic production of iron ores, and relied on importation from China and Korea.

A factor determining size of the future iron and steel capacity of Japan will, no doubt, be availability of iron ore. Domestic reserves can provide ores containing 1 million tons of metallic iron annually, not sufficient to satisfy

TABLE V

PRODUCTION OF NICKELIFEROUS ORES IN JAPAN AND THEIR NICKEL AND IRON CONTENT, 1937–1945

(IN METRIC TONS)

| *Year* | *Tonnage Mined* | *Nickel Content* | *Iron Content* |
|---|---|---|---|
| 1937 | 33,984 | 102 | 5,100 |
| 1938 | 45,440 | 136 | 6,800 |
| 1939 | 139,026 | 657 | 32,850 |
| 1940 | 150,056 | 750 | 37,500 |
| 1941 | 378,924 | 1,664 | 83,200 |
| 1942 | 265,151 | 1,435 | 71,750 |
| 1943 | 390,869 | 2,247 | 112,350 |
| 1944 | 428,284 | 2,527 | 126,350 |
| 1945 (5 mos.) | 158,282 | 886 | 44,300 |

Source: Ministry of Commerce and Industry (Japan), Bureau of Mines.

normal Japanese needs. Possibilities of importing ores from abroad will be limited. To conserve her iron ore reserve, China will probably prohibit iron exports. A very large part of Korean deposits are of low grade and therefore not suitable for peacetime use. In the Philippines and Malaya the Japanese may find the Australians competing, who are beginning to show keen interest in iron ore deposits of the Pacific area. It is possible that iron deposits of Indo-China and the East Indies may be developed for export to Japan, but this will take time and capital. Taking all the above into consideration one would be safe in assuming that the iron content of the ores available for Japanese importation will not be more than 1 million tons in the near future.

## COAL AND COKE

Coal reserves of Japan belong mostly to the Tertiary period, far younger than the coal deposits of Europe and the Eastern United States. Japanese coals, for the most part bituminous, usually contain excessive impurities, volatile matter, and ash; and they lack binding power. With exception of coals coming from Yubari Mine in Hokkaido and Futase Mine in Fukuoka, Japanese coals are not suitable for making metallurgical coke. Domestic coking coal production, amounting to 1.5 million tons, 75 per cent of which came from Yubari, was far from sufficient to take care of requirements of Japanese blast furnaces; and one ton of coking coal for every ton of pig iron produced was imported during 1940–1943. (According to Supreme Commander for the Allied Powers, *Summation of Non-Military Activities in Japan*, No. 1, Sept.–Oct. 1945, p. 61, Japanese coking coal imports during 1940–1944 have been as follows:

| | |
|---|---|
| 1940 | 3,315,000 metric tons |
| 1941 | 3,417,000 metric tons |
| 1942 | 4,025,000 metric tons |
| 1943 | 2,939,000 metric tons |
| 1944 | 1,435,000 metric tons) |

Almost all imports of coal came from North China, mainly from Kaiping mines northeast of Tientsin. When mixed with Japanese coal, coking coals of North China produce coke that is technically satisfactory, though inferior to that used in the United States. The main disadvantage of the cokes was their high cost, since it takes 1.5–1.7

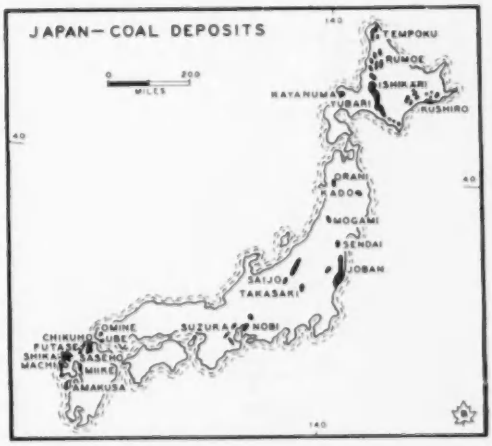


FIGURE 3.—Coal Deposits of Japan. The coals of Japan are found almost solely in Tertiary deposits, are for the most part bituminous, usually contain excessive impurities, volatile matter, and ash, and lack binding power. The coals are not suitable for making metallurgical coke, except from the Yubari Mine in Hokkaido, and the Futase Mine in Fukuoka.

TABLE VI

PRODUCTION AND IMPORTATION OF SOME OF THE RAW MATERIALS OF JAPANESE STEEL INDUSTRY, 1934–1944
(Quantities in Thousands of Metric Tons)

| *Items* | *1934* | *1935* | *1936* | *1937* |
|---|---|---|---|---|
| *Iron Ore:** | | | | |
| Total Production | *215* | *260* | *309* | *296* |
| Total Imports | *1,399* | *2,185* | *2,415* | *2,554* |
| Korea | 90 | 121 | 121 | 151 |
| Manchuria | 2 | ..... | ..... | 1 |
| China | 495 | 757 | 751 | 358 |
| Philippines | 4 | 175 | 342 | 362 |
| Malaya | 760 | 929 | 1,066 | 1,029 |
| Others | 48 | 203 | 135 | 653 |
| Total Iron Ore Supply | *1,610* | *2,441* | *2,724* | *2,850* |
| Production Supply Ratio | 13.4% | 10.7% | 11.3% | 10.4% |
| Iron Sand* | *1* | *3* | *2* | *6* |
| Pyrite Sinters* | ..... | ..... | ..... | ..... |
| Nickeliferous Iron* | ..... | ..... | ..... | 5 |
| Total Iron Supply | *(1,611)* | *(2,444)* | *(2,726)* | *(2,861)* |
| *Pig Iron:* | | | | |
| Pig Iron Production | *1,728* | *1,865* | *1,972* | *2,252* |
| Pig Iron Imports | *777* | *1,093* | *1,095* | *1,131* |
| Manchuria | 409 | 383 | 271 | 213 |
| Korea | 164 | 131 | 123 | 135 |
| Others | 205 | 579 | 701 | 793 |
| Total Supply | *2,505* | *2,958* | *3,067* | *3,383* |
| *Sponge Iron Production* | ..... | ..... | ..... | ..... |
| *Scrap:* | | | | |
| Domestic Scrap | *1,669* | *1,781* | *1,942* | *2,994* |
| Purchased | 1,100 | 1,100 | 1,100 | 1,100 |
| Self-generated | 569 | 681 | 842 | 1,894 |
| Imports | *1,413* | *1,692* | *1,497* | *2,420* |
| Total Supply | *3,082* | *3,473* | *3,439* | *5,414* |
| Consumption | *2,538* | *3,122* | *3,337* | *4,394* |
| Balance | *544* | *351* | *107* | *1,020* |
| *Steel Ingot Production* | *3,844* | *4,703* | *5,217* | *5,798* |

*The figures for iron ore, iron sand, pyrite sinters, nickeliferous iron are in terms of their iron content.
Source: Compiled from data supplied by Japanese Bureau of Mines, Iron and Steel Control Association, *Japan–Manchoukuo Year Books*.

tons of coal to produce one ton of coke in Japanese coke ovens. Furthermore, due to the high ash content of the coke, despite the use of high grade imported ores, coke consumption per ton of pig iron was somewhat larger than that of the United States.

Quality of Japanese coals used in the iron and steel industry, other than for blast furnace operation, was satisfactory. Although Japan experienced a severe coal shortage during the 1937–1945 war period, the iron and steel industry, being on the preferential list, always obtained a sufficient supply.

Charcoal is one of the most important sources of carbon added to molten steel to increase its carbon content. The large household consumption of charcoal and its high price are factors limiting its use in the production of pig iron.

Consumption of coal in the iron and steel industry reached about 13.7 million tons a year in 1943 when the industry was utilizing 50–60 per cent of its installed capacity (see Table VII). A 90 per cent utilization of facilities would have required 23 million tons of coal, 13 million for coke and 10 million for fuel, which would have been impossible to supply.

In our discussion of the Japanese iron ore supply we have found that the metal content of iron ores that may be available in the near future for Japanese use will be about 2.0 million tons, the equivalent of 3.8 million tons of iron ore. To smelt the ore the Japanese will need about 4.7

TABLE VI—*Continued*

PRODUCTION AND IMPORTATION OF SOME OF THE RAW MATERIALS OF JAPANESE STEEL INDUSTRY, 1934–1944

(Quantities in Thousands of Metric Tons)

| *1938* | *1939* | *1940* | *1941* | *1942* | *1943* | *1944* |
|---|---|---|---|---|---|---|
| *364* | *447* | *557* | *745* | *1,179* | *1,459* | *1,911* |
| *1,906* | *2,928* | *3,052* | *3,015* | *2,911* | *2,147* | *944* |
| 184 | 200 | 220 | 380 | 339 | 120 | 329 |
| 2 | 7 | 28 | 31 | 37 | ..... | 5 |
| 88 | 411 | 705 | 1,529 | 2,424 | 1,920 | 595 |
| 556 | 712 | 754 | 300 | 17 | 76 | 14 |
| 1,008 | 1,220 | 1,286 | 752 | 57 | 27 | ..... |
| 68 | 378 | 59 | 23 | 37 | 4 | ..... |
| *2,270* | *3,375* | *3,609* | *3,760* | *4,090* | *3,606* | *2,855* |
| 16.0% | 13.2% | 15.4% | 19.8% | 29.0% | 45.3% | 66.9% |
| *33* | *24* | *63* | *110* | *173* | *201* | *227* |
| ..... | ..... | ..... | ..... | ..... | *422* | *204* |
| 7 | 33 | 38 | 83 | 72 | *112* | *126* |
| *(2,310)* | *(3,432)* | *(3,710)* | *(3,953)* | *(4,335)* | *4,341* | *3,412* |
| *2,467* | *3,068* | *3,417* | *4,088* | *4,306* | *3,813* | *2,713* |
| *1,072* | *927* | *854* | *784* | *878* | *1,134* | *942* |
| 210 | 352 | 431 | 553 | 715 | 681 | 586 |
| 215 | 221 | 164 | 133 | 133 | 270 | 245 |
| 647 | 352 | 259 | 93 | 30 | 183 | 112 |
| *3,539* | *3,995* | *4,271* | *5,872* | *5,184* | *4,947* | *3,655* |
| ..... | *1* | *11* | *26* | *47* | *81* | *98* |
| *3,219* | *3,075* | *2,935* | *3,040* | *3,369* | *3,588* | *3,083* |
| 1,100 | 890 | 871 | 1,022 | 1,251 | 1,292 | 1,317 |
| 2,199 | 2,185 | 2,064 | 2,018 | 2,118 | 2,296 | 1,766 |
| *1,358* | *2,555* | *1,391* | *203* | *39* | *25* | *74* |
| *4,577* | *5,630* | *4,376* | *3,242* | *3,408* | *3,613* | *3,157* |
| *4,265* | *4,660* | *4,405* | *4,487* | *4,777* | *5,275* | *4,195* |
| *312* | *970* | *-79* | *-1,244* | *-1,369* | *-1,662* | *-988* |
| *6,461* | *6,693* | *6,855* | *6,837* | *7,099* | *7,821* | *5,911* |

*The figures for iron ore, iron sand, pyrite sinters, nickeliferous iron are in terms of their iron content.

Source: Compiled from data supplied by Japanese Bureau of Mines, Iron and Steel Control Association, *Japan–Manchoukuo Year Books*.

million tons of coking coal. As indicated above, normal coking coal production is 1.5 million tons. Assuming that satisfactory coke is obtainable by 50–50 mixture of Japanese non-coking coals and imported coals, respectively, need for imported coals will be about 1.6 million tons. The amount could be obtained from Kailan mines of Northern China and from the Russian island of Sakhalin.

## SCRAP IRON AND PIG IRON

As result of scarcity of iron ore and metallurgical coking coal, the Japanese steel industry made use of imported scrap and pig iron in the manufacture of steel. During the thirties Japan became the world's largest importer of scrap as well as pig iron.

Until 1940 the Japanese steel industry used an exceptionally high proportion of scrap in manufacturing steel. Between 1930 and 1939 imports of scrap iron increased by approximately 500 per cent. In some steel, scrap constituted 70 per cent of the raw materials. Between 1933 and 1939 the United States provided annually more than half of the Japanese import of scrap and in 1939 about 80 per cent of scrap imports came from the United States.

In January, 1940, the commercial treaty between the United States and Japan expired; and in October, President Roosevelt placed an embargo on export of scrap to Japan. Japan was already

cut off from her European sources of scrap. Since domestic supply of scrap was inadequate (Table VI), and since neighboring Asiatic countries are small consumers of iron and steel and therefore small producers of scrap iron, restrictions were imposed on the use of scrap. First, a maximum limit of 60 per cent scrap was established in 1940. As the stockpiles of scrap dwindled, the ratio of scrap to ingot steel was further reduced. In 1944 for every ton of ingot steel 44 parts of scrap and 56 parts of pig iron was used. If the present steel capacity is to be fully utilized, a domestic scrap supply of 3.0 million tons would be sufficient to provide a scrap to pig iron ratio of only 20 to 80.

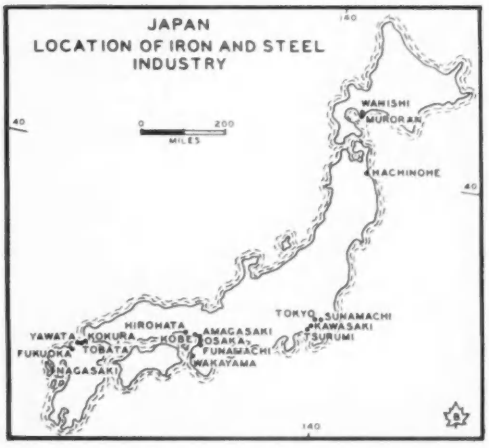


FIGURE 4.—Location of Iron and Steel Industry. Like concentration of the productive capacity in the hands of a few integrated firms, the iron and steel industry of Japan represents high degree of geographic concentration, highest in blast furnaces and progressively less as the product passes through various subsequent stages of production. Location of blast furnaces has been determined primarily by accessibility to raw materials and market at lowest total cost; location of steel works has been determined largely by location of blast furnaces and economies effected in bringing the two operations together. Japanese iron and steel industry is concentrated in five areas: (1) Southern Hokkaido, (2) Northern Honshu, (3) Tokyo–Yokohama, (4) Osaka–Kobe–Hirohata, and (5) Northern Kyushu.

Japanese imports of pig iron reached a million tons in 1935 and maintained the high position until 1944. In 1935 Japan's imports of pig iron were equal to the combined imports of the ten next largest importers. Japan's position as chief importer of pig iron in the world was due to increase in scrap prices beginning with 1936 and also to the fact that no large size merchant blast furnaces existed in Japan. Producers of pig iron utilized their entire production for steel making, so no pig iron went into the market and therefore those steel companies which did not operate blast furnaces had either to purchase scrap or import pig iron.

Manchuria has maintained a high position among the exporters of pig iron to Japan (Table VI). Korea has been a smaller, but reliable source of imported pig iron. British India has supplied an amount varying from 150–400,000 tons during 1930–1939. The Soviet Union became an important supplier only in 1935 and 1936, but has since disappeared from the Japanese market. The United States exports of pig iron to Japan, insignificant in the early thirties, suddenly assumed outstanding importance in 1937 and 1938, only to revert to their previous status in 1939. During 1940–44, pig iron other than that imported from Manchuria and Korea came from North China, thanks to Japanese efforts at building and repairing blast furnaces in China.

Future supply of pig iron imports depends on ability of the Chinese and the Koreans to rejuvenate and operate Japanese-built blast furnaces in their countries. It is common knowledge that industrialization of China, Manchuria and Korea has not progressed to such a point as to make use of all pig iron that could be produced there. Hopes of obtaining pig iron from other former exporters such as British India, Soviet Russia and the United States in the near future are negligible, since

all three have ample domestic use for their pig iron and may have an even greater demand in the future.

### FERRO-ALLOYS

The ferro-alloy industry has developed rapidly during the fifteen-year period between 1930–1944, particularly from 1935 to 1940 (Table VIII). The annual capacity of the ferro-alloy plants increased 1,000 per cent between 1931 and 1945. The capacity in 1931 was less than 20,000 tons.

During the war Japan imported only a small part of the ores and ore concentrates required for the production of ferro-alloys; domestic reserves of manganese, chrome, tungsten, vanadium, nickel, although of low grade, are of considerable size. Furthermore, there are deposits of exportable size of various alloy metals in Korea and China, and were obtained from them.

A new series of alloy steels was developed during the war in Japan, as well as in other countries, to conserve supplies of critical alloys. The steels contain relatively little alloy; yet in many applications they are as serviceable as higher alloy steels for which they have been substituted. It appears that possibilities of further development in this field have not yet been fully exploited.

### TECHNOLOGY

It is not the purpose of this paper to discuss well known methods of making pig iron and steel; however, something should be said about some of the unique technical processes in Japan. Because most of the iron deposits of Japan and its former possessions of Korea and Manchuria are low grade, because smelting costs rise rapidly with the amount of slag-forming constituents in the ore, and because Japan, Korea and Manchuria are short in suitable smelting fuels, Japanese scientists paid much attention to beneficiation of iron ores. Heavy solution concentration and magnetic concentration techniques were devised in Japan, and European processes were adapted to Japanese ores.

Perhaps the most commonly used iron beneficiation method employed in Japan is based on a modification of French Basset and German Krupp-Renn proc-

TABLE VII

CONSUMPTION OF COAL IN JAPAN PROPER BY IRON AND STEEL INDUSTRY
FISCAL YEARS 1934–1944
(IN THOUSANDS OF METRIC TONS)

| *Item* | *1935* | *1936* | *1937* | *1938* | *1939* | *1940* | *1941* | *1942* | *1943* | *1944* |
|---|---|---|---|---|---|---|---|---|---|---|
| Imports of coal | ..... | ..... | ..... | ..... | *8,285* | *10,123* | *9,585* | *8,748* | *6,029* | *3,135* |
| Karafuto | ..... | ..... | ..... | ..... | 2,542 | 3,328 | 3,310 | 2,198 | 1,650 | 807 |
| Korea | ..... | ..... | ..... | ..... | 1,011 | 1,467 | 1,078 | 910 | 496 | 252 |
| Manchuria | ..... | ..... | ..... | ..... | 848 | 773 | 687 | 642 | 414 | 561 |
| Formosa | ..... | ..... | ..... | ..... | 255 | 263 | 39 | 175 | 5 | ..... |
| North China | ..... | ..... | ..... | ..... | 3,042 | 3,800 | 4,120 | 4,539 | 3,389 | 1,515 |
| Indo China, etc. | ..... | ..... | ..... | ..... | 587 | 492 | 351 | 284 | 75 | ..... |
| Imports—coking coal | ..... | ..... | ..... | ..... | ..... | *3,315* | *3,417* | *4,025* | *2,939* | *1,435* |
| Coal for iron and steel | *5,259* | *6,129* | *6,639* | *7,986* | *10,057* | *11,439* | *13,171* | *13,315* | *13,702* | *11,241* |
| For coke | 4,130 | 4,339 | 4,941 | 5,573 | 6,718 | 7,997 | 8,972 | 8,424 | 7,938 | 6,190 |
| For fuel | 1,129 | 1,790 | 1,698 | 2,413 | 3,339 | 3,442 | 4,199 | 4,891 | 5,764 | 5,051 |

Source: Compiled from U. S. Strategic Bombing Survey, *The Effects of Strategic Bombing on Japan's War Economy*, Appendix Tables C-43, C-44, C-45.

esses. Pulverized low grade iron, iron sand or iron pyrite is placed in rotary kilns with lime and fuel. Reduced iron comes out in the form of rice-sized grains. They are called *luppe* and are removed from dross by magnetic separators. The luppe contain as high as 96 per cent iron, 0.7–1.50 per cent carbon, 0.02–0.1 per cent sulphur and 0.07–0.2 per cent phosphorous. There are several variations of the basic process. In one variation high frequency current is applied to the mixture, to reduce the amount of fuel required from about 2,500 lbs. of anthracite or charcoal to only about 900 lbs. per ton of concentrated iron produced. Electricity consumption per ton is high, however, about 2,600 kwh being required. Another variation which produces sponge iron and cement clinker at the same time was practiced by Asano Cement Company between 1940 and 1945. Ordinary cement kilns are used. The iron obtained is quite free from sulphur (thanks to the high lime composition of the slag) containing only 0.01 per cent.

The rotary kiln reductions of iron may produce either concentrated iron for further smelting in the blast furnaces or sponge iron which can be used in steel furnaces. Any kind of fuel varying from low grade coal to charcoal and gas can be used and there is no necessity for scarce metallurgical coke. The rotary furnaces cost less to build than the blast furnaces. In spite of such advantages of the sponge iron process over the conventional method, it has the following limitations:

1. The product is not uniform;
2. The high-frequency process, which produces a higher quality sponge iron, requires about 2,600 kwh per ton of iron produced;
3. About 30 per cent of the iron in the ore cannot be recovered.

Japanese rotary kiln sponge iron becomes costly and impractical under present technical methods for peacetime use.

During the war, sponge iron was also made in brick kilns. By the method iron ore dust was mixed with lime, coal or coke, placed in fire-clay containers, and heated in brick kilns to a temperature of 1,250° C. for 24 to 30 hours. The produce was used as melting stock for steel making. The process proved to be economically unsuccessful and only about 10,000 tons of sponge iron has been made by this method.

## STRUCTURE OF THE IRON AND STEEL INDUSTRY

Various functions of the Japanese iron and steel industry tend to explain the

TABLE VIII

PRODUCTION OF FERRO-ALLOY IN JAPAN PROPER, 1935–1944

(IN METRIC TONS)

| *Items* | *1935* | *1936* | *1937* | *1938* | *1939* | *1940* | *1941* | *1942* | *1943* | *1944* |
|---|---|---|---|---|---|---|---|---|---|---|
| Ferro-Manganese | ..... | 34,922 | 54,080 | 66,927 | 61,456 | 70,728 | 51,323 | 71,354 | 55,283 | 44,533 |
| Ferro-Silicon-Manganese | ..... | 3,774 | 4,352 | 3,377 | 6,286 | 10,440 | 17,230 | 16,855 | 7,864 | 12,655 |
| Ferro-Silicon | 15,571 | 15,313 | 11,632 | 20,513 | 30,035 | 36,877 | 33,388 | 25,741 | 23,491 | 30,578 |
| Ferro-Chromium | 4,078 | 6,424 | 8,597 | 15,141 | 13,966 | 14,716 | 21,222 | 21,664 | 31,382 | 19,998 |
| Ferro-Tungsten | 272 | 447 | 804 | 1,479 | 2,499 | 3,274 | 2,949 | 2,152 | 3,216 | 1,567 |
| Ferro-Molybdenum | 188 | 199 | 285 | 672 | 1,415 | 1,802 | 988 | 546 | 365 | 337 |
| Ferro-Vanadium | ..... | ..... | 31 | 45 | 578 | 708 | 832 | 533 | 322 | 224 |
| Ferro-Titanium | ..... | 13 | 25 | 46 | 160 | 213 | 125 | 117 | 243 | 278 |
| Ferro-Phosphorous | ..... | ..... | ..... | ..... | ..... | 2,745 | 1,376 | 1,547 | 1,157 | 977 |

Source: The United States Strategic Bombing Survey, *The Effects of Strategic Bombing on Japan's War Economy*, Appendix Table C-28, p. 120.

structure of the industry. It is the task of the industry to:

1. Reduce iron ore to pig iron or to sponge iron;
2. Combine pig iron, sponge iron, scrap, and alloy materials into steel; and
3. Shape the ingot steel into semi-finished and finished products.

The companies which perform all the listed functions may be classified as integrated companies. Five Japanese concerns belong in this category: Nippon Seitetsu, Nippon Kokan, Nakayama, Amagasaki, and Kokura. The largest of the concerns, Nippon Seitetsu, in addition to blast furnaces, steel works, rolling mills, forge shops, and foundries which are also owned by the others, operates ore and coal mines and limestone quarries, and maintains ore carriers.

Companies making and rolling ingot steel but producing no pig or sponge iron are classified as semi-integrated. Until 1935, all the above-mentioned integrated companies other than Nippon Seitetsu belonged to this class, not having yet built their blast furnaces. At present, the five large semi-integrated companies are Kawasaki Jukogyo, Kobe Seikosho, Sumitomo Metals, Japan Steel and Yamato.

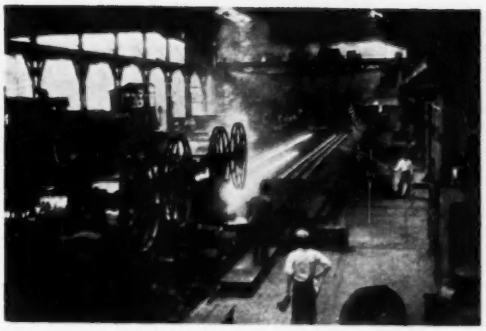

FIGURE 5.—Interior of a rolling mill near Tokyo. The plant is semi-mechanized as seen from hand cooling of steel. Application of a large unit of labor to restricted capital is a common feature of Japanese industry.

The companies engaged in steel rolling may be classified as non-integrated and those which manufacture only pig iron and/or sponge iron or ingot steel may be classified as merchant furnaces.

The number of companies and distribution of capacity in each of the above-defined classes are shown in Tables IX and X.

Four important facts emerge from an analysis of Tables IX and X: (1) Integrated companies, dominate production of pig iron; (2) Nippon Seitetsu, largest of the integrated companies is an important factor in the Japanese iron and steel picture; (3) Semi-integrated and merchant furnaces companies are important in production of steel ingot only: (4) Merchant furnaces are unimportant as pig iron producers.

Large scale operation of both company and plant is a universal characteristic of the iron and steel industry. Integration in the Japanese iron and steel industry conforms to world patterns. Economies that come from integration are largely savings incident to heating and moving the product in large masses, since large bodies maintain their heat more readily than small ones.

## LOCATION OF THE IRON AND STEEL INDUSTRY

Concentration of the bulk of productive capacity in the hands of a few integrated firms is paralleled by high degree of geographic concentration in the iron and steel industry of Japan. (Map IV.) The geographic concentration is highest in blast furnaces and becomes progressively less as the product passes through the various subsequent stages of production. Location of blast furnaces has been determined primarily by promise of accessibility to raw materials and market at the lowest total cost. Since Japan lacks adequate supplies of both coking coal and iron, large

blast furnaces were built at tidewater, convenient for receiving imported supplies. Local raw materials such as coal, ores, limestone, and a large supply of water were also important factors in the location of the Japanese blast furnaces.

Location of steel works has been determined largely by location of blast furnaces and economies effected in bringing the two operations together. Such economies are result of (1) transforming pig iron into steel in the same plant without letting the iron cool, (2) using by-product gases from blast furnaces and coke ovens, and (3) avoiding cost of transportation of pig iron. Proximity to densely populated industrial areas has been important in locating steel mills not equipped with blast furnaces, because here their chief raw material, scrap, and markets for steel are found together.

Making of rolled steel products is more widely scattered throughout Japan than is production of pig iron and steel.

Merchant blast furnaces, sponge iron facilities, and merchant steel furnaces are also widely scattered, located in areas where ore, fuel and cheap power are found.

The Japanese iron and steel industry is concentrated in five areas: (1) southern Hokkaido, (2) northern Honshu, (3) Tokyo-Yokohama, (4) Osaka-Kobe-Hirohata, (5) northern Kyushu. Beyond the five there are few sponge iron and steel furnaces, and their importance is negligible. Before turning to detailed consideration of each district, attention is called to Table XI, which presents in summary the present and past relative importance of each region, based upon its productive capacity of pig iron.

### SOUTHERN HOKKAIDO

*Wanishi and Muroran.* One of the more important iron and steel centers of Japan is located in the Iburi prefecture of Hokkaido, in and about the tidewater town of Muroran. There are two companies operating in the area, Nippon Seitetsu and Japan Steel. The first, an integrated company, owns and operates 3,000 acres of iron ore properties in Iburi, iron sand properties in various parts of Hokkaido, limestone quarries in northern Honshu, blast furnaces, and steel mills. The second, semi-integrated company has a plant at Muroran manufacturing steel and steel products.

Blast furnaces of Nippon Seitetsu near Muroran belong to two groups: old furnaces of two 225-ton and two 350-ton daily capacity at Wanishimachi; and new furnaces of three 700-ton capacity at nearby Nakamochi. The furnaces were designed to use southern

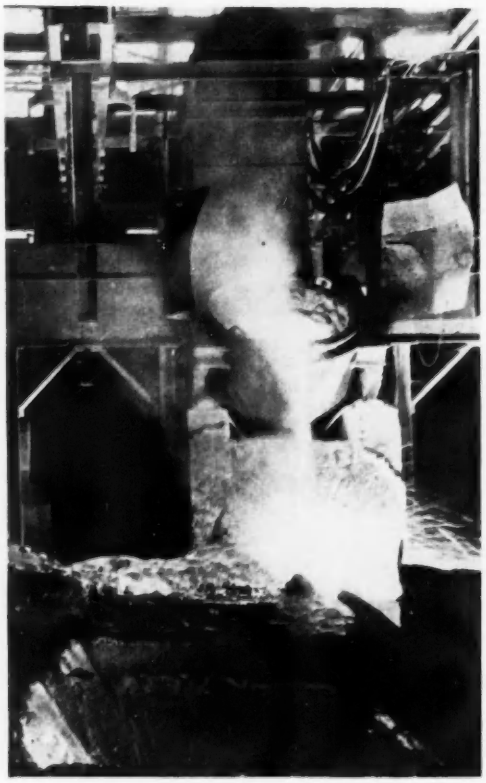

FIGURE 6.—A small electric furnace in the Sumitomo Company plant, near Osaka. In comparison to other steel producing countries, Japan produces relatively more of its steel in electric furnaces.

Hokkaido's limonite ores, which contain 45–53 per cent iron, 0.05 per cent sulphur and 0.06 per cent phosphorus. Since southern Hokkaido limonite contains high amounts of moisture and in damp weather absorbs additional amounts, it causes occasional trouble if used alone and for best results is mixed with imported ores from China and Korea. To improve the smelting quality of the Hokkaido ores sintering was widely practiced during the war. Normally, when imported ores were available, 30 per cent of the ore entering the Hokkaido blast furnaces was sintered, but during 1944 as much as 60 per cent sintered ore was used. There are 19 Greenwalt machines with an annual capacity of 920,000 tons and two Dwight and Lloyd machines with a 600,000 ton capacity. About 40 per cent of the total sintering capacity of Japan is in southern Hokkaido.

Coking coal comes from Yubari mines in central Hokkaido and is cleaned and converted to coke at Wanishi. Although Yubari coals coke easily and have a low sulphur content, they are brittle and high in ash. With ore containing high moisture and coke containing much ash, it is readily seen that in spite of its easy reducibility, coke consumption per ton of pig iron would be relatively high.

Steel-making equipment of Nippon Seitetsu in Hokkaido consists of five tilting-type open-hearths, each of 100,000-

TABLE IX

PRINCIPAL BLAST FURNACES, OPEN-HEARTH PLANTS, AND ROLLING MILLS IN JAPAN, 1945

(CAPACITY FIGURES IN METRIC TONS)

| *Company and Plant* | *Blast Furnaces* | | *Open-hearth Plant* | | *Rolling Mills* | |
|---|---|---|---|---|---|---|
| | *No. of Furnaces* | *Annual Capacity* | *No. of Furnaces* | *Annual Capacity* | *Primary Capacity* | *Secondary Capacity* |
| *Integrated Companies* | | | | | | |
| Nippon Seitetsu: | | | | | | |
| Yawata | 12 | 2,190,000 | 46 | 2,413,000 | 2,570,000 | 2,000,000 |
| Wanishi | 7 | 1,185,000 | 5 | 500,000 | 600,000 | 180,000 |
| Kamaishi | 3 | 602,000 | 10 | 587,000 | 600,000 | 380,000 |
| Hirohata | 2 | 730,000 | 6 | 600,000 | 600,000 | 450,000 |
| Fuji | .. | ..... | ... | ..... | ..... | 120,000 |
| Nippon Kokan: | | | | | | |
| Kawasaki | 5 | 931,000 | 13 | 360,000 | 400,000 | 300,000 |
| Tsurumi | 2 | 182,000 | 8 | 348,000 | 300,000 | 280,000 |
| Amagasaki, Amagasaki | 1 | 128,000 | 4 | 205,000 | 132,000 | 238,000 |
| Nakayama, Funamachi | 2 | 314,000 | 5 | 203,000 | 86,000 | 170,000 |
| Kokura, Kokura | 2 | 256,000 | 5 | 72,000 | ..... | 62,000 |
| *Semi-integrated Companies* | | | | | | |
| Kawasaki Jukogyo: | | | | | | |
| Kobe | .. | ..... | 10 | 350,000 | ..... | ..... |
| Osaka | .. | ..... | ... | ..... | 192,000 | 156,000 |
| Kobe Seikosho, Kobe | .. | ..... | 9 | 276,000 | 216,000 | 180,000 |
| Japan Steel Works, Muroran | .. | ..... | 16 | 276,000 | 52,000 | 38,000 |
| Sumitomo Metals: | | | | | | |
| Wakayama | .. | ..... | 4 | 110,000 | ..... | 60,000 |
| Osaka | .. | ..... | 4 | 98,000 | ..... | 30,000 |
| Amagasaki | .. | ..... | 3 | 90,000 | 180,000 | 61,000 |
| Yamato Osaka | .. | ..... | 5 | 167,000 | ..... | ..... |
| *Non-integrated Companies* | .. | ..... | ... | ..... | 1,794,000 | n.a. |
| *Merchant Furnaces** | | | | | | |
| Nichia, Amagasaki | .. | ..... | 3 | 86,000 | ..... | ..... |
| Osaka, Osaka | .. | ..... | 4 | 72,000 | ..... | ..... |
| Hitachi, Mito | .. | ..... | 2 | 81,000 | ..... | ..... |
| Others | 18 | 68,000 | 31 | 532,000 | ..... | ..... |
| *Total* | 54 | 6,586,000 | 193 | 7,426,000 | 7,722,000 | 6,500,000e. |

*Excludes rotary kilns. e.Estimate. n.a.Not available.

TABLE X

STRUCTURE OF JAPANESE IRON AND STEEL INDUSTRY BY PER CENT OF TOTAL CAPACITY OWNED BY INTEGRATED, SEMI-INTEGRATED, NON-INTEGRATED, AND MERCHANT FURNACE COMPANIES IN 1945

(CAPACITY FIGURES IN METRIC TONS)

| *Degree of Integration* | *Number of Companies* | *Pig Iron Capacity* | *Per Cent* | *Open-hearth Capacity* | *Per Cent* | *Primary Rolling Capacity* | *Per Cent* |
|---|---|---|---|---|---|---|---|
| Integrated | 5 | 5,518,000 | 95.4 | 5,288,000 | 71.2 | 5,288,000 | 68.5 |
| Nippon Seitetsu | (1) | 4,707,000 | 81.4 | 4,100,000 | 55.2 | 4,370,000 | 56.6 |
| Semi-integrated | 5 | ..... | .... | 1,367,000 | 18.4 | 640,000 | 8.3 |
| Non-integrated | 22 | ..... | .... | ..... | .... | 1,794,000 | 23.2 |
| Merchant furnaces* | 17 | 268,000 | 4.6 | 771,000 | 10.4 | ..... | .... |
| Total | 49 | 5,786,000 | 100.0 | 7,426,000 | 100.0 | 7,722,000 | 100.0 |

*Merchant furnaces include merchant blast furnaces, steel furnaces, and sponge iron facilities.

ton annual capacity, one blooming mill, one continuous-bar mill, and one wire rod mill. Part of the steel-making installations were damaged as result of military action in 1945. The principal products were billets, wire rod, wire and pig iron.

Pig iron produced in excess of requirements for making steel in Nippon Seitetsu works was sold to the Japan Steel Works in Muroran. They have 16 open-hearths with total yearly capacity of 276,000 tons.

If Japan is to depend entirely on her domestic coal and iron supply, the Wanishi-Muroran units will assume a leading position because they are the only Japanese iron and steel units with access to domestic reserves of both commercial size coking coal and iron ore. The present size of the plant capacity, however, is too great for raw materials available, which are sufficient for a yearly production of 500,000 tons of pig iron and 700,000 tons of steel ingot, and 600,000 tons of primary rolled products.

### NORTHERN HONSHU

Kuji iron sand deposits, which have been discussed under the heading of "Iron Ore," are located in northeastern Honshu. The iron sands are concentrated and then shipped to special furnaces where they are converted into a product containing 72–80 per cent iron, varying quantities of titanium, silicon, lime, manganese and 0.2–9.4 per cent vanadium. Iron sand smelting furnaces owned by Japan Iron Sand Steel Industries Company are located at Hachinohe in the prefecture of Aomori. The facilities have a total capacity of about 100,000 tons of sponge iron a year. The 1944 production of sponge iron at Hachinohe was only 26,434 tons. Sponge iron is used in open hearths as a scrap substitute or is treated in electric furnaces for making vanadium steels.

*Kamaishi.* The Kamaishi plant is near the town of the same name in Iwate Prefecture, only a few miles from the Pacific Ocean. The facilities in 1944 included 7 Greenwalt and 2 Dwight and Lloyd sintering machines with a total annual capacity of 112,000 tons; one 350-ton, one 600-ton, and one 700-ton blast furnaces; 10 open-hearth furnaces; 3 electric furnaces; 1 blooming mill; 6 rolling mills, and miscellaneous equipment. Principal products were pig iron, ingot and semi-finished steel. About 60 per cent of the sintering plant, 40 per cent of the blast furnace capacity, 50 per cent of the open-hearth capacity, and 70 per cent of the rolling capacity

were damaged in 1945. Part of the damage has been repaired.

The Kamaishi works are owned by the Nippon Seitetsu, which also owns the largest single ore deposit in Japan, 12 miles west of the blast furnaces. The Kamaishi ore body contains 12 million tons of high grade magnetite and 30 million tons of lean ores. Lean ores are beneficiated and used in the blast furnaces with the rich ores. To conserve local reserves, the Kamaishi blast furnaces imported iron ore from northern Korea and from the Yangtze Valley, and coal from Karafuto and Hokkaido by sea. Imported ores and the coal from Karafuto will probably not be available in the future. Using local ore alone Kamaishi can produce 300,000 tons of pig iron, part of which can be converted to steel at Kamaishi and the remainder shipped to the Tokyo-Yokahama industrial area. There appears to be very little use in the future for badly damaged old and inefficient rolling mills, which could be reconditioned only at great expense.

### TOKYO-YOKOHAMA

At first glance the region does not look promising for an iron and steel industry: it is neither near large iron ore reserves nor does it provide coking coal. Nevertheless, a large pig iron industry was established to supply the already existing steel mills, which had been built to provide the largest market in Japan with both ingot and finished steel.

Blast furnaces are conveniently located at tidewater, along the protected coast of Tokyo Bay, for receiving ore and coal supplies from other parts of the Far East. In 1936, Malayan ores from a distance of about 2,900 miles were delivered to Yokohama area for $2.20 a ton, an amount not much higher than the cost of transporting Minnesota ores to the Lake Erie ports. (According to the U. S. Tariff Commission Report, No. 128, *Iron and Steel*, p. 316, the cost of shipping the ores from Minnesota to the Erie ports in 1936 was $1.73.) In addition, ores were also imported from the Philippines and China. Coke requirements were met by mixing Karafuto, Hokkaido, and Chinese coals, cheaply transported by waterway. Noncoking coals came by rail from Joban field, 100 miles north of Tokyo.

There are two integrated units in Tokyo-Yokohama region, besides many smaller establishments engaged in one or more phases of the iron and steel industry. The two integrated units are owned by Nippon Kokan (Japan Steel Tube Co.) and are located at Kawasaki, south of Tokyo and at Tsurumi, near Yokohama.

*Kawasaki*. The works have three 600-ton, one 400-ton, and one 350-ton blast furnaces with annual capacity of931,000 tons of pig iron. Two of the 600-ton

TABLE XI

TOTAL BLAST FURNACE CAPACITY OF JAPAN IN METRIC TONS AND PERCENTAGE SHARE OF EACH MAJOR DISTRICT

| *District* | *1928* | *1936* | *1944* | *1946* |
|---|---|---|---|---|
| Total blast furnace capacity | 1,089,000 | 2,277,000 | 6,585,000 | 5,614,000 |
| Percentage share of: | | | | |
| Northern Honshu | 16.3 | 15.2 | 9.1 | 6.8 |
| Tokyo–Yokohama | 6.9 | 20.0 | 16.9 | 17.8 |
| Osaka–Kobe–Hirohata | .7 | ..... | 17.8 | 13.0 |
| Northern Kyushu | 57.4 | 44.1 | 37.1 | 42.0 |
| Southern Hokkaido | 14.3 | 18.4 | 18.0 | 20.3 |
| Others | 4.4 | 2.3 | 1.4 | .1 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |

furnaces are ready to operate, but the other three require repairs to auxiliary equipment damaged during the war. In 1944 steel ingot capacity was 620,000 tons composed of 13 open-hearths and 5 Bessemer converters, and the rolling mill capacity was 400,000 tons. Bombings by American air forces reduced the first to 280,000 and the latter to 170,000 tons. Finishing equipment includes 1 blooming mill, 3 tube mills, 1 sheet-bar mill, and 3 small rolling mills. Principal products of Kawasaki are seamless tubes and pipes of all sizes, bars, rods and fertilizers.

*Tsurumi.* Iron and steel works at Tsurumi are smaller than those of Kawasaki. They contain one 200-and one 300-ton blast furnace and 8 open hearths, 1 slab and plate mill, and 3 plate and sheet mills. Tsurumi produced plates and sheets. Installations there are badly damaged.

Besides the above-mentioned units, there are in the Tokyo-Yokohama area: Azuma Seikosho Steel Co. with a plant at Sunamachi, eastern suburb of Tokyo; the Fuji rolling mills of Nippon Seitetsu at Kawasaki; the Ashai Seitetsu with facilities in Tokyo, and many others engaged in operating open hearths, electric furnaces, rolling mills, foundries, and rotary sponge iron furnaces. Most installations have been damaged.

In the near future there should be no pig iron production in the Tokyo-Yokohama area. The extent of steel ingot production should depend on availability of scrap and sponge iron. Under such limitations the production of steel ingots would probably be less than 500,000 tons. Production of finished and semi-finished steel, however, could be larger than that of steel ingots, since some ingot steel would probably be shipped from Hokkaido and from northern Honshu for further processing.

### OSAKA–KOBE–HIROHATA

The area, like the Tokyo-Yokohama area, depends for its coal and iron ore on outside sources of supply. Until 1945, coking coal was imported from North China and non-coking coal came mainly from Kyushu. Iron was mostly imported, though some was supplied from hematite deposits in Shikoku and from iron sand deposits of Shimane-Tottori prefectures and Tanegashima Island. There are in the area three integrated units: Amagasaki plant of Amagasaki Seitetsu, Funamachi plant of Nakayama, and Hirohata plant of Nippon Seitetsu. Besides, there are numerous semi-integrated, non-integrated and merchant furnace companies. The more important among the semi-integrated group are Kawasaki Jukogyo, Kobe Seikosho, and Sumitomo Kinzoku Kogyo, all located in Kobe-Osaka industrial area and engaged in the production of open-hearth steel and rolled products. Kawasaki has two mills. Kobe Seikosho, slightly smaller than Kawasaki, includes the only large wire rope rolling mill in Japan. Sumitomo has 7 open-hearths and 4 electric furnaces in mills located in Amagasaki, Osaka and Wakayama and specializes in forgings, castings and alloys.

*Funamachi.* Nakayama Company, established in 1924 to manufacture steel and rolled steel products, began manufacturing pig iron in 1936. Its facilities, located at Funamachi, near Osaka, consist of two 420-ton furnaces built in 1936 and 1941, 5 open-hearths with a total ingot steel capacity of 203,000 tons, and a secondary rolling capacity of 170,000 tons. The blast furnaces have been out of operation since 1944, and half of the total steel furnace and rolling mill capacity has been damaged.

*Amagasaki.* A single blast furnace of 350 tons daily capacity is owned by

Amagasaki-Seitetsu and is located at Amagasaki, a suburb of Osaka. The furnace has been out of operation since 1944. Amagasaki also has 4 open-hearths with a total annual capacity of 250,000 tons and well-equipped rolling mills to process the ingot steel produced.

*Hirohata.* In 1937 the Japanese government announced a plan of establishing a new iron and steel center with a capacity of 730,000 tons of pig iron, 600,000 tons of steel ingots, and 450,000 tons of rolled steel products. The job of building and operating the facilities was assigned to Nippon Seitetsu. Hirohata, up to that time an insignificant spot on the maps and west of Kobe between Shikama and Aboshi, was selected as the location. The seclusion of the spot from foreigners, strategic considerations, cheap land and abundant water supply provided by Yumemae Gawa, were determining factors in locating the plant.

The Hirohata plant has only two blast furnaces, completed in 1938 and 1939. The furnaces are among the largest individual units in Japan, having a daily capacity of 1,000 tons. The other two furnaces of this size are at Yawata. Part of the pig iron produced was supplied to small steel plants in the Osaka-Kobe area and the rest was converted to steel at Hirohata. Steel-making equipment consisted of six 150-ton open-hearth furnaces and the largest continuous-plate mill in Japan. The principal products were heavy armor and ship plate. The equipment is in good shape due to the fact that the plants were not included among U. S. bomber targets. As soon as enough fuel for smelting can be obtained, the furnaces can start operating, using Shikoku iron ores.

### NORTHERN KYUSHU

*Yawata.* The Yawata plant was established in 1901 by the Japanese government with a rated capacity of 58,000 tons of pig iron and 70,000 tons of ingot steel. The Russo-Japanese War of 1904–1905 and World War I of 1914–1918 acted as great stimuli to the iron and steel industry and as a result the plant was greatly enlarged. Production rose from 30,000 tons of pig iron in 1901 to 177,000 tons in 1912, to 400,000 tons in 1922, and to 1,330,000 tons in 1936. In 1934, the Yawata iron and steel works were turned over by the government to the newly organized Nippon Seitetsu.

The Yawata iron and steel installations are located at tidewater, convenient for receiving foreign supplies of ore and coal on which the plant depends. The major part of the plant is located on the south side of Dokai Wan, an inlet safe from all winds, although a smaller part is located north of Tobata city, on the outer Wakamatsu Harbor. The lay-out of the plant prior to 1930 was not satisfactory, since the steel mills were placed on the shoreside, while the blast furnaces were inland, necessitating transportation of the ore, which up to this point had been entirely water-carried, by overhead cableways above the steel mills and the rolling mills. Since this defect, however, has been partly corrected by building of the new furnaces on the waterfront, in the area reclaimed from Dokai Wan, the cost of handling ore has been cut down considerably.

At the end of 1929 Yawata had one 150-ton, three 200-ton, one 230-ton, two 270-ton and one 300-ton (a total of eight) blast furnaces. Subsequently new large furnaces have been built and a part of the old equipment has been reconditioned and others were moved to China. Today there are three 300-ton, two 350-ton, three 400-ton, one 500-ton, one 700-ton and two 1,000-ton furnaces (a total of twelve) with an annual pig iron capacity of 2,190,000 tons. At present three furnaces, one 300-ton,

one 350-ton and one 700-ton are operating, but their production per furnace is only about 100 tons of pig iron a day. Most of the blast furnace equipment is in good condition, not having suffered from bombings.

Not only has Yawata the largest installations in Japan, but it also may be classified among the most important iron and steel facilities in the world. Besides the 12 blast furnaces, there are 46 open hearths with 2,413,000 ton capacity, 13 electric furnaces, 7 blooming mills, and 21 rolling mills which can produce anything from heavy slabs to tin plate.

The iron ores used in Yawata came from Korea, Malaya, the Philippine Islands, and Chahar, Shantung and Yangtze in China. During 1942–1944, the iron ore supply was augmented by the use of domestic pyrite sinters at a rate of 300–400,000 tons a year. The Yanahara mine in Okayama and the Besshi mine in Ehime were the chief sources of iron pyrite.

Yawata obtained coking coal from Futase mine in Fukuoka prefecture and Shikamachi mine in Nagasaki prefecture and also imported coal from mines of Kailan, Tatung, and Shantung in North China. Usually imported coals were blended with the domestic coals at the ratio of 40 to 60 respectively. While attempts to blend imported coking coals with larger proportions of domestic coal have been partially successful, the resultant product is not highly desirable since it causes slowdowns in blast furnace operations. During the first half of 1943, 58 per cent of the coking coal used by Yawata was low grade domestic. The percentage rose to 62 in the first half and to 68 in the second half of 1944. Non-coking coals and limestone are obtained from nearby mines and quarries of Kyushu.

Proximity to both domestic and imported sources of fuel, limestone, iron ores, make Yawata one of the more economic iron and steel producing units of Japan, even though cost of production of pig iron and therefore of steel and steel products are high in comparison to that in United States. High transportation costs between Japan and iron and steel exporting countries justify maintenance of Yawata as a steel center. However, since all existing capacity cannot be economically utilized, only the newer equipment should be kept and the remainder dismantled.

*Kokura.* At Kokura, a town east of Yawata, the iron and steel works of Kokura Seiko are located. The works are composed of two 350-ton blast furnaces, 5 open hearths with an annual capacity of 72,000 tons and a rolling mill with a 62,000 ton capacity. The

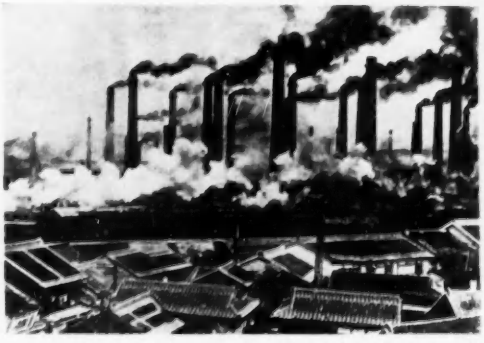

FIGURE 7.—A long-range view showing a small section of the Yawata works. This picture shows about one-tenth of the area of the entire works, which may give some idea of their size. This is a pre-war photograph; now most of the smoke stacks are idle

company, a veteran in steel manufacturing, decided in 1937 to enter the iron smelting field in order to satisfy its pig iron needs. The first furnace was built in 1938 and the second in 1943. Difficulties in obtaining raw materials prevented successful operation. The first furnace was partly dismantled and the second never used. In the future Kokura can exist only as an adjunct to Yawata and not as a separate integrated unit.

## SUMMARY AND CONCLUSION

Japanese iron and steel production registered significant increases in the decade from 1934–43. This fact is illustrated by Table XII and the following summary production figures:

| | *1926/29 Average* | *1940/44 Average* |
|---|---|---|
| Pig iron | 971,000 tons | 3,722,000 tons |
| Ingot steel | 1,848,000 tons | 6,898,000 tons |
| Finished steel | 1,606,000 tons | 4,966,000 tons |

Though the output increased, it could not keep pace with the expansion of capacity, mainly because of shortages of iron ore, coking coal, and imported pig iron and scrap.

Scarcity of steel began to develop in 1937. To insure equitable distribution of steel among industries, a quota system was set up immediately following outbreak of hostilities with China in July. Coincidentally, steps were taken to curb output of structural steel, thereby making available more steel for war equipment. Restrictions on civilian use was intensified in 1938 by new regulations banning use of iron in the manufacture of about 56 widely used commodities, such as paper weights, scissors, and pots and pans.

In spite of such restrictions, demand for finished steel jumped from about four million tons in 1936 to seven million in 1940. The steel industry found it impossible to increase its production to satisfy growing demands. The government was forced to curtail requirements of even essential industries, and the planned national defense output was not attained. Even tanks, motor vehicles, and heavy artillery were assigned low priority number, and shipping, though it rated a high priority, was chronically short of steel. Low production of iron and steel was primary limiting factor for the whole war economy of Japan.

An ambitious program of capacity expansion continued up to 1945. By 1944 blast furnace capacity had reached 6,585,000 tons, and steel ingot capacity amounted to 13,968,000 tons. For the same year, pig iron production was 2,713,000 tons and steel ingot production was 5,911,000 tons, an indication that blast furnaces were operating only at 41 per cent of their capacity (United States—92 per cent for 1944), and steel furnaces at 42 per cent of capacity (U. S. 96 per cent). At Yawata, for instance, one 350-ton blast furnace had operated between 1942–1945 at a daily production level of only 100 tons. Several newly constructed blast furnaces, including those of Amagasaki Steel Works and Nakayama Steel Works, had to be shut down after a short period of operation because of shortage of raw materials. Operation of a small per-

FIGURE 8.—Yawata steel center. This picture, covering only one-fifth of the total area of the plant, may give a rough idea about the size of the largest iron and steel works of Japan.

centage of capacity meant high fixed costs per ton of iron and steel produced and this in turn created additional burden on Japanese war finances.

High level imports of coking coal, iron ore and scrap were requirements necessary for the full-scale operation of Japan's iron and steel industry. Decline in the imports began in 1941 and reached critical proportions in 1944. In case of iron ore and scrap substantial drafts were made on existing stockpiles. Decline in the imports of Chinese coal by 60 per cent between 1942 and 1944 forced the Japanese to utilize greater quantities of best available domestic coal.

Japan's surrender and the resulting sharp drop in coal production reduced iron and steel output to a mere trickle. Japan now produces at a yearly rate of slightly over 120,000 tons of pig iron, 500,000 tons of steel ingots, and 350,000 tons of finished steel. In July, 1946, it was decided to concentrate all Japanese blast furnace operations at Yawata to eliminate wasteful consumption of coal in a great number of plants operating only at small fraction of their capacity. This will continue until larger coal supplies will be available. Besides Yawata, which produces both pig iron and steel, Kawasaki plant of Nippon Kokan (Japan Steel Tube) and Kobe plant of Kobe Seikosho are making ingot steel from scrap, which is fabricated into pipes in Kawasaki and wire ropes in Kobe.

Japan emerged from the hostilities with a blast furnace capacity of

TABLE XII

PRODUCTION OF INGOT STEEL AND FINISHED STEEL IN JAPAN PROPER, 1934–1944

(QUANTITIES IN THOUSANDS OF METRIC TONS)

| *Items* | *1934* | *1935* | *1936* | *1937* | *1938* | *1939* | *1940* | *1941* | *1942* | *1943* | *1944* | *1945* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ingot Steel: | | | | | | | | | | | | |
| Hokkaido | *77* | *77* | *65* | *77* | *76* | *83* | *81* | *121* | *256* | *436* | *334* | .... |
| Open Hearth | 77 | 77 | 65 | 77 | 74 | 81 | 79 | 118 | 252 | 425 | 320 | .... |
| Electric | .... | .... | .... | .... | 2 | 2 | 2 | 3 | 4 | 11 | 14 | .... |
| Honshu | *1,904* | *2,493* | *2,858* | *3,336* | *3,788* | *3,990* | *4,153* | *4,081* | *4,293* | *4,785* | *3,722* | .... |
| Open Hearth | .... | 2,303 | 2,612 | 2,986 | 3,095 | 3,058 | 2,981 | 2,695 | 2,717 | 2,826 | 1,921 | .... |
| Bessemer | .... | .... | .... | .... | 59 | 152 | 233 | 333 | 352 | 331 | 197 | .... |
| Electric | .... | 190 | 246 | 350 | 634 | 780 | 939 | 1,053 | 1,224 | 1,628 | 1,604 | .... |
| Kyushu | *1,863* | *2,133* | *2,294* | *2,385* | *2,597* | *2,620* | *2,621* | *2,635* | *2,550* | *2,600* | *1,855* | .... |
| Open Hearth | .... | 2,082 | 2,224 | 2,300 | 2,477 | 2,514 | 2,479 | 2,470 | 2,358 | 2,307 | 1,614 | .... |
| Electric | .... | 51 | 70 | 85 | 120 | 106 | 142 | 165 | 192 | 293 | 241 | .... |
| Total | *3,844* | *4,703* | *5,217* | *5,798* | *6,461* | *6,693* | *6,855* | *6,837* | *7,099* | *7,821* | *5,911* | *1,065* |
| Open Hearth | .... | 4,462 | 4,901 | 5,363 | 5,646 | 5,653 | 5,539 | 5,283 | 5,327 | 5,558 | 3,855 | 610 |
| Bessemer | .... | .... | .... | .... | 59 | 152 | 233 | 333 | 352 | 331 | 197 | .... |
| Electric | .... | 241 | 316 | 435 | 756 | 888 | 1,083 | 1,221 | 1,420 | 1,932 | 1,859 | 455 |
| Steel Imports | *89* | *274* | *242* | *434* | *300* | *214* | *291* | *152* | *163* | *183* | *102* | *2* |
| Finished Steel: | | | | | | | | | | | | |
| Cast | *80* | *100* | *116* | *158* | *234* | *259* | *236* | *286* | *289* | *329* | *329* | .... |
| Forged | *71* | *72* | *82* | *97* | *130* | *151* | *173* | *182* | *175* | *208* | *178* | .... |
| Rolled | *3,114* | *3,745* | *4,272* | *4,680* | *4,876* | *4,676* | *4,532* | *4,153* | *4,052* | *4,149* | *2,632* | .... |
| Rails | .... | 367 | 289 | 217 | 283 | 361 | 366 | 292 | 262 | 171 | 78 | .... |
| Shapes | .... | 468 | 555 | 728 | 664 | 600 | 635 | 581 | 582 | 479 | 266 | .... |
| Bar | .... | 1,025 | 1,034 | 1,207 | 1,321 | 1,268 | 1,258 | 1,201 | 992 | 902 | 559 | .... |
| Sheets | .... | 484 | 660 | 609 | 521 | 423 | 572 | 505 | 396 | 372 | 263 | .... |
| Wire rods | .... | 413 | 487 | 447 | 401 | 383 | 330 | 345 | 339 | 312 | 170 | .... |
| Plates | .... | 713 | 878 | 1,063 | 1,280 | 1,177 | 822 | 806 | 1,037 | 1,475 | 971 | .... |
| Pipes | .... | 167 | 189 | 224 | 226 | 270 | 261 | 249 | 238 | 236 | 226 | .... |
| Special | *58* | *104* | *124* | *212* | *328* | *463* | *443* | *499* | *650* | *923* | *1,181* | .... |
| Total | *3,323* | *4,021* | *4,954* | *5,147* | *5,568* | *5,549* | *5,384* | *5,120* | *5,166* | *5,609* | *4,320* | .... |

Source: Compiled from U. S. Strategic Bombing Survey, *The Effects of Strategic Bombing on Japan's War Economy*, Appendix Tables C-21, C-22, C-23; and others.

5,614,000 tons and a steel furnace capacity amounting to 11,694,000 tons. Reparations, plus the fact that Japan does not need all her iron and steel facilities in peacetime, make maintenance of all of the capacity impossible. Need for finished steel, iron casts, and alloys for Japanese peacetime use may be estimated at 4,200,000 tons, distributed among various consumers as follows:

| | |
|---|---|
| Agriculture | 70,000 tons |
| Automotive | 60,000 tons |
| Construction | 960,000 tons |
| Containers | 150,000 tons |
| Household goods | 100,000 tons |
| Machinery and tools | 800,000 tons |
| Mining | 310,000 tons |
| Oil, gas, water | 240,000 tons |
| Railroads | 410,000 tons |
| All others | 1,100,000 tons |

Of the entire amount needed, 3,850,000 tons would be finished steel and 350,000 tons cast iron. Assuming that demand for finished steel from 1948 to 1950 will be about 3,850,000 tons annually, it would require 4,500,000 tons of ingot steel; to produce so much steel Japanese will need 5,125,000 tons of pig iron and scrap. To the figure 350,000 tons for casting should be added, thus bringing total demand for scrap and pig iron to 5,475,000 tons. Previous discussion in the early part of this paper concerning iron ore supply has demonstrated that pig iron production in Japan would likely be limited to 2,000,000 tons. Domestic supply of scrap would probably be around 3,000,000 tons annually, thanks to the damage of war, to leave a shortage of 475,000 tons, which must be imported as pig iron and/or scrap.

Because of scarcity of iron ore and in order to conserve equally scarce coking coal, the steel industry once more should be made dependent on scrap in any effort of constructing Japan. Since, however, domestic scrap supply would be limited to 2,500,000 tons after 1950, assuming the scrap created by war damages would be used by that time, Japan should be allowed to keep a blast furnace capacity of 2,500,000 tons out of an existing 5,600,000 tons. From an economic point of view, the furnace capacity should be distributed as follows:

| | |
|---|---|
| Yawata | 1,000,000 tons |
| Wanishi | 500,000 tons |
| Hirohata | 500,000 tons |
| Kamaishi | 500,000 tons |

In case of steel furnaces a capacity of 5,000,000 tons should be maintained.

The above analysis indicates that under present technical conditions Japan will not be able to increase her production of iron and steel to the level achieved in the decade of 1935–44, and with the above proposed steel production of less than four million tons of finished steel, Japanese can never hope to attain an economic and political position among the leading nations of the world.

# STABILITY OF ANNUAL EMPLOYMENT—CINCINNATI AND SELECTED CITIES

*Victor Roterus*

THE economy of an urban area can be said to be at its best when those who seek work are able to find it under conditions conducive to maximum income. One such condition is stability of annual employment or, in other words, absence of pronounced seasonal fluctuations.

This paper analyzes seasonal employment in Cincinnati. Cincinnati's seasonal performance relative to 29 other cities is compared and its seasonal patterns of employment are described.

## Inter-city Comparisons

Comparable figures on seasonal employment exist only on a city, and not on a metropolitan basis, in the United States Census. Such city figures are available only for the single year of 1939. Furthermore, they indicate seasonality of employment only by the number of months out of the year that the workers were employed. Month-by-month pattern of that employment must be determined from other sources.

According to the Census figures, Cincinnati exhibited better than average stability of annual employment in 1939. Sixty-six per cent of Cincinnati's non-agricultural workers were employed 12 months of the year (i.e. 50 weeks or more) in 1939, as compared to an United States average of 60 per cent and an Ohio average of 59 per cent.

Comparisons with 29 other cities are shown in Figure 1. The other cities were selected because of availability of comparable data on wage levels and cost of living used in connection with other studies. Cities are divided into two groups on the map: (1) those with better seasonal employment performance than Cincinnati in 1939, and (2) those with inferior performance. Digits indicate the percentage that those workers who had 12 months employment in 1939 were of all employed workers.

Of the selected 29 cities, eight had greater employment stability than Cincinnati, 18 less stability, and three (Columbus, Indianapolis, and New Orleans) had almost identical stability. Best performance was exhibited by Washington, D. C., with 75 per cent of its workers having 12 months' employment, and least stability was evident in Detroit where only 48 per cent of the workers had 12 months' employment.

There is no apparent correlation between annual employment stability in the various cities and their distribution with respect to climate. Areas having pronounced seasons contain cities both with relatively high and low stability, and areas with less well-defined seasons are similarly characterized. In the North, for example, note dissimilar performances of Boston (69 per cent) and Providence (56 per cent). And in the South, note Atlanta with 68 per cent of its workers having 12 months' employment whereas in Birmingham only 62 per cent worked 12 months. Similarly on the West Coast, performance of Seattle in the North was identical with Los Angeles in the South. Such lack of correlation is understandable in view of the fact that, except for construction and agriculture, urban activities involve only a relatively negligible number of workers who operate outside

shelter. Construction and agriculture, furthermore, command only about 4 to 6 per cent of total employment, and thus do not exercise significant effect on the totals.

Correlation does exist between stability performance of cities and dominant types of employment activities found in the cities, as is evident from Table I which shows the major industrial groups as classified by the Census. Outstanding in stability of annual employment are activities of "government" and "finance, insurance and real estate." The categories of "transportation, communication, and utilities" and "trade" following in ranking. At the bottom of the list are "construction" and extractive industries. Nationally, manufacturing exhibits mediocre performance with only 55 per cent of its workers employed 12 months in 1939, but Cincinnati's seasonal stability in this broad industry grouping is notably good (64 per cent).

The facts of seasonal stability are reflected by performance of cities in which such industries have varying degrees of representation. Governmental activity is relatively important in

FIGURE 1.—Comparison of permanency of employment in Cincinnati with that of other cities in the United States.

Washington, Denver, and Columbus—all having relatively high seasonal stability. Trade centers of Atlanta and Dallas, for example, are also clearly above average.

TABLE I

PERCENTAGE OF WORKERS EMPLOYED 12 MONTHS, 1939

| *Industry Group* | *Cincinnati* | *Ohio* | *United States* |
|---|---|---|---|
| NON-AGRICULTURAL INDUSTRIES, TOTAL | 66 | 59 | 60 |
| ALL INDUSTRIES, TOTAL | 66 | 58 | 58 |
| Government | 87 | 82 | 83 |
| Finance, insurance and real estate | 85 | 84 | 85 |
| Transportation, communication and utilities | 78 | 70 | 72 |
| Wholesale and retail trade | 69 | 67 | 68 |
| Business and repair services | 65 | 63 | 66 |
| Personal services | 65 | 58 | 60 |
| Manufacturing | 64 | 56 | 55 |
| Professional and related services | 59 | 50 | 51 |
| Agriculture, forestry, fishing, and mining | 54 | 42 | 40 |
| Amusement and recreation services | 50 | 49 | 51 |
| Construction | 28 | 26 | 30 |

Among manufacturing centers, Cincinnati shares high ranking with Baltimore, Minneapolis, and several others. In notable contrast were such manufacturing centers as Cleveland with only 58 per cent of its workers having year-around employment in 1939, and Detroit with lowest ranking of all (48 per cent). Obviously, the clue to such divergent performances lies in the fact that, within manufacturing activity as a whole, various types of manufacturing differ greatly as to their seasonal performance. The automotive industry, with heavy concentration in Detroit, is normally among the least stable types seasonally because of its annual retooling requirement. Other types of manufacturing which performed poorly on a seasonal basis, at least in 1939, include textile mill products (important in Providence), leather products, wood products, and radios. On the other hand, grain-mill products (important in Minneapolis) and petroleum refining (important in Houston) exhibited relatively high seasonal employment stability in 1939.

Another seasonal index available for Ohio and its counties indicates average range of employment between high and low months on the basis of data over the 11-year period of 1926 through 1936. The data were developed by the Bureau of Business Research of Ohio State University from workmen's compensation records of the Ohio Department of Industrial Relations. The range is determined by calculating the difference between minimum monthly and maximum monthly seasonal indexes, as computed from monthly data for the 11-year period, and then expressing the difference as per cent of the maximum seasonal index.

The 11-year seasonal data on Hamilton County (Cincinnati's parent county) corrobate, in the main, the more limited Census data. In particular, they indicate that Cincinnati's relatively good showing in seasonal stability of its manufacturing industry is largely due to the fact that predominant types of manufacturing found there are generally less subject to seasonal fluctuation than is true of the average pattern of manufacturing in the United States.

Among large employers in the Cincinnati area which have good records for seasonal stability are the following types of manufacturing: Foundry and machine-shop products including machine tools; printing, publishing and lithographing; meat packing; bakery products; and soap and chemicals. Apparel industry is largely comprised of men's clothing, a more stable type of manufacturing than women's clothing. All such types have relatively higher degree of representation in the Cincinnati pattern than they do in the national pattern, as measured by their respective percentages of total manufacturing employment in Cincinnati and the United States.

Among industries in the Cincinnati area exhibiting inferior performances from the viewpoint of annual stability of employment were automobiles and parts, furniture and office fixtures, and radios and parts. Employment in such industries, however, is relatively small compared with more stable performers, and except for radios, such industry types are not as important percentage-wise in the local pattern as they are in the national pattern.

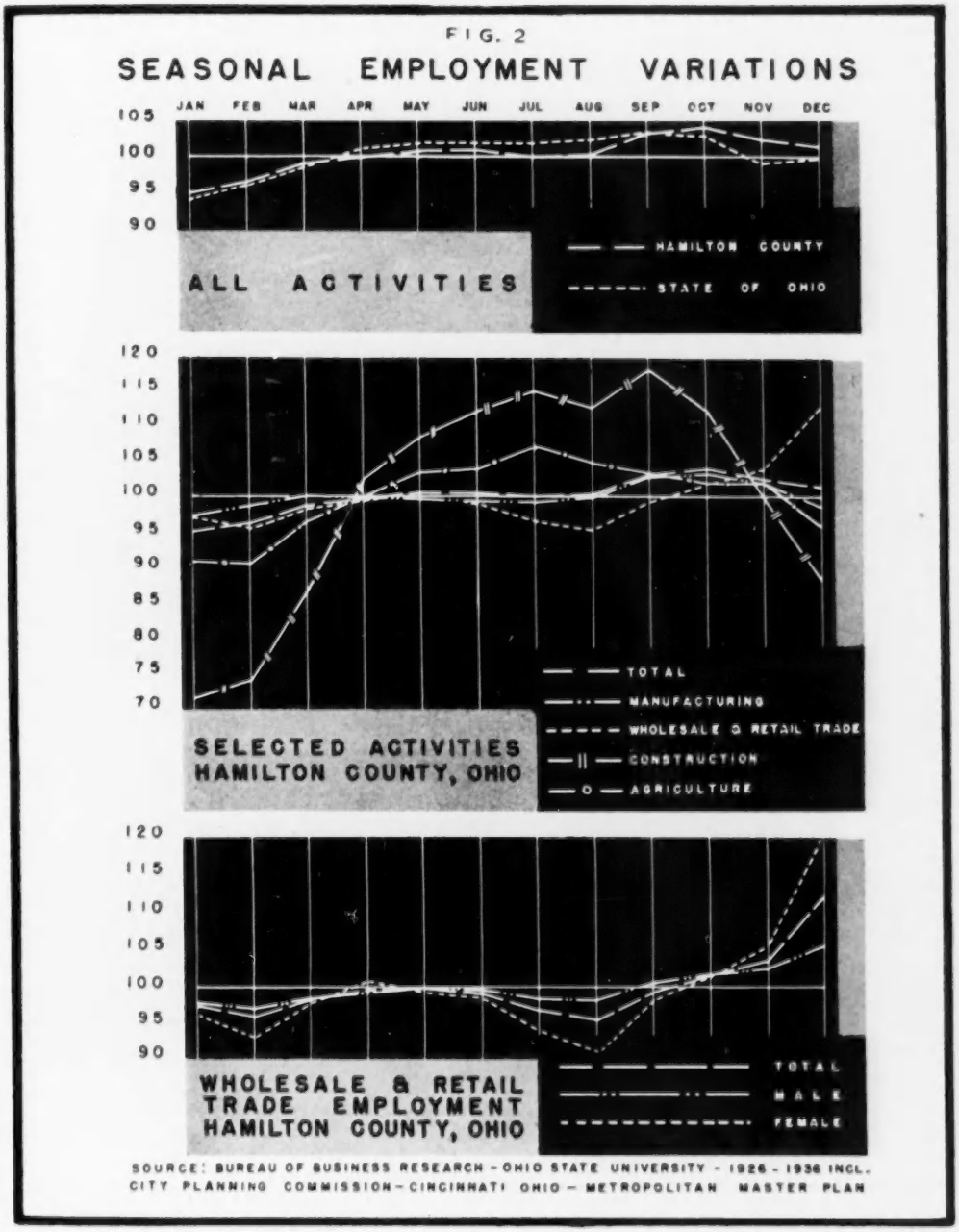


FIGURE 2.—Seasonal employment variations in various activities of Hamilton County, Ohio.

### SEASONAL PATTERNS IN THE CINCINNATI AREA

The 11-year data show some interesting seasonal patterns in Hamilton County.

Overall employment had one peak, that in the fall. Low ebb of employment came in mid-winter as a rule, but did not reach as low a level as for the state as a whole (see Figure 2). In terms of 1939,

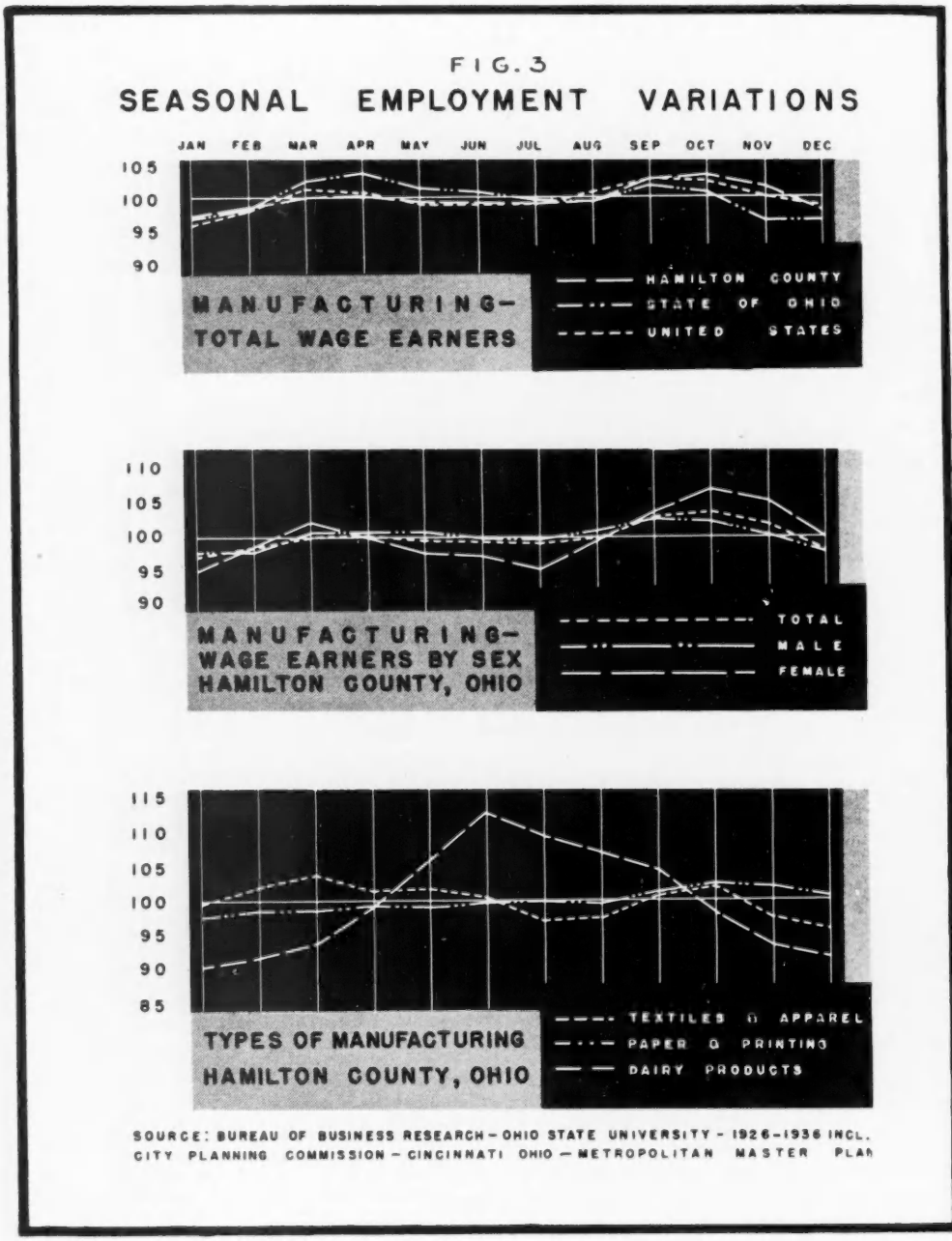


FIGURE 3.—Seasonal employment variations by types of manufacturing, and by sex in Hamilton County, Ohio, and comparison of total wage earners in manufacturing in Hamilton County with Ohio and United States.

employment in lowest months in Hamilton County was about 12 thousand less than in highest months. The fall peak was caused largely by the seasonal pattern of manufacturing which had about a third of the total employment.

Widest employment swings were evident in construction and agriculture—the only two major industries in which a large amount of non-sheltered work is involved. Construction had a double peak of employment in the months of July and September, and agriculture's hired workers reached a peak in July.

Retail and wholesale trade employment, second largest employer in the metropolitan county, had summer and late winter lows and a pronounced early winter rise coincidental with Christmas shopping. The percentage range was fifteen. Male employment was much more stable seasonally than female employment in this industry. Many workers in the trades were students or others who were interested only in part-time employment.

In manufacturing, the single peak in fall distinguishes Hamilton County from Ohio and United States which had spring peaks as well (Figure 3). Seasonal patterns of the various types of industries in Hamilton County were exemplified by paper and printing with fall peak, textiles with twin peaks in the spring and fall, and dairy products and ice cream with summer peak. Larger employers, including most metals industries, featured a fall peak.

It is in the interest of a community to reduce its seasonal unemployment to a practical minimum. It is also in the interests of a particular business or plant to do so.

Some seasonality of employment, such as that catering to Christmas shopping, is inevitable; and some persons, like those going to school, desire only part-year work. On the whole, however, seasonal unemployment in urban areas still permits of much reduction. It is, furthermore, more susceptible to remedial action by businesses within that area than unemployment occasioned by the business cycle, which is largely caused by national or international conditions and policies.

Within a particular business, many methods—such as better scheduling of production in advance of orders, addition of new products which can be produced during the slack season in established lines, concessions to encourage customers to buy and stock out of season—are available to stabilize employment throughout the year. Industries which cannot level out their production throughout the year, can make arrangements to dovetail their employment with establishments whose seasonal fluctuations are complementary. In Hamilton County, for example, the dairy products industry which includes ice cream has its peak employment during summer months and its lowest employment during winter months. The confectionery industry has exactly the opposite seasonal pattern of employment. To a degree, required skills in the two industries are similar, and there is opportunity for interchange of workers between them to minimize adverse effects of the seasonal character of their employment.

# A GROWTH MAP FOR THE MANCHESTER REGION

*Henry Rees*

GROWTH maps have been published for Edinburgh, Leeds, Plymouth, Cambridge, and on a small scale for London; (Edinburgh: J. Bartholomew, Scot. Geog. Mag. 1919; Leeds: W. T. Lanchashire, Brit. Assocn. Handbook, Leeds, 1927; Plymouth: Shorter and Woodley, "Geography," Vol. 22, 1937, p. 293; Cambridge: Mitchell, Brit. Assocn. Report, 1938, Appendix p. 162; London: I.C.C., Growth of Greater London, No. 3442, 1939. See also the writer's "A Growth Map for Northeast London during the Railway Age," Geog. Rev., July, 1945, p. 458) but one feels that they have been regarded as little more than a curiosity; at all events, excepting perhaps in case of Cambridge, little attempt has been made to provide reasoned interpretation of the features portrayed. Yet a growth map provides a useful summary of ways in which settlements have risen and flourished or decayed, and shows how their shapes have been affected or even moulded by physical and human environments.

The map here reproduced illustrates growth of the Manchester region—"the busiest tract of land in all the world"—and is, the writer believes, first of its kind to appear for any industrial region.

## Construction of the Map

For the base map the most recently published 1″ map was used, namely, the 2nd War Revision, Popular Style, Sheet 36, 1940. From this map through roads, railways, rivers, canals and reservoirs were inserted. On the base map were added successive increases in urban area as revealed by the 1″ Ordnance Survey maps from the First Edition onwards. Some simplification was inevitable.

Details of the sheets used are given in the following table:—

| *Number* | *Edition* | *Name* | *Surveyed or Revised* | *Published* |
|---|---|---|---|---|
| 88, 89 | First | ..... | no details | 1843 |
| 80, 81 N.W. | " | ..... | " " | 1843 |
| 85 | Second | Manchester | revised 1895, Lancs. and Yorks. added 1896 | 1896 |
| 98 | " | Stockport | revised 1895, Lancs. added 1895 | 1896 |
| 84 | " | Wigan | ..... | 1896 |
| 97 | " | Runcorn | ..... | 1896 |
| 76 | " | Rochdale | ..... | 1896 |
| 85 | Third | Manchester | revised 1911 | 1913 |
| 76 | " | Rochdale | " 1912 | 1913 |
| 98 | " | Stockport | " 1905 | 1908 |
| 97 | " | Runcorn | " 1904–5 | 1907 |
| 84 | " | Wigan | " 1910 | 1912 |
| 36 | Popular | ..... | revised 1920–21 | 1924 |
| 36 | Popular Style | Bolton and Manchester | 2nd. war revision, 1940 | 1942 |

It should be noted that the map does not necessarily indicate ages of existing buildings, but only the period in which land first became built up. During the century covered by the map much reconstruction took place, especially in central parts of the urban settlements.

In a general way, period boundaries so discovered, partake of the nature of isopleths. From their very nature they cannot cross, though they can and frequently do merge. Close together they indicate a dormant or decaying settlement; far apart, an actively expanding settlement. No doubt much interesting material would emerge from comparison between Social Geography of one settlement such as Altrincham, which has expanded regularly throughout the whole period, and another, such as Walkden, which has grown little since 1895.

## Physical Basis

The region comprises foothills of the Rossendale Moors and of part of the western slopes of the Southern Pennines, together with an undulating plain sloping gently down southwestward. Though it has been developed on rocks of Coal Measure and Triassic age, over the greater part of the region these are masked by extensive deposits of Boulder Clay, glacial sands and gravels, and peat; it is such superficial deposits rather than the underlying rocks which have influenced distribution of settlement.

In general alluvial and peat lands have been rigorously avoided. Thus, in the Salford district the boundary between Boulder Clay and alluvium passes parallel with and a short distance south of the Eccles road. Here there is a sudden check to housing development southwards and eastwards. Absence of settlement between Farnworth and Swinton is explained by presence there of a considerable tract of peat moss, while a smaller peat area adjoining Ashton on the west, explains the fact that all housing development since 1810 has taken place on the eastern side of the town.

Both gravel and clay areas have been utilised extensively for dwelling sites, but there appears to be a natural preference for building on gravels; thus Heywood has ceased its westward growth at the point where gravel gives way to Boulder Clay, and Royton is similarly situated on the southern verge of gravels; Middleton has grown on a narrow strip of gravel connecting westwards with gravels of the Prestwich area, while the core of Bolton corresponds quite closely with a tract of gravel regarded as deltaic material deposited in a glacial lake.

Nevertheless, in contrast to recent developments in northeast London, most of Manchester, Oldham and Ashton, and much of Bury, has been developed on Boulder Clay.

In growth of the girdle of towns surrounding Manchester natural routes and local features of relief have played an important part. Bolton, Bury, Roch-

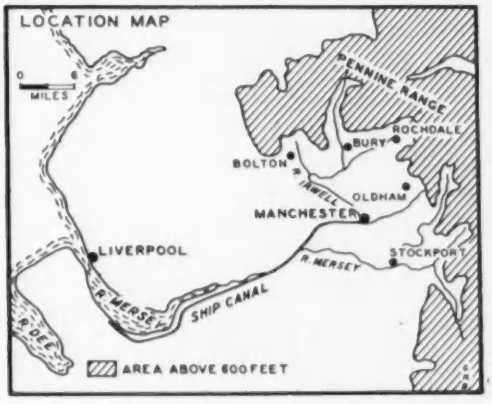


Figure 1.—The relationship of Manchester and its environs to the Pennine Range and the Mersey estuary is clearly revealed by the location map. The importance of the ship canal is clearly brought out.

dale, Oldham and Ashton-under-Lyne may be compared to the line of foothill towns on the eastern border of the Pennines. Both groups developed as convenient ford or bridge points and as market towns at the junction of dissimilar regions; their growth was aided by natural routes cut back into the Pennines by the streams on which they were situated.

Later development has been favoured by the prevalence in most cases of subdued relief. Thus Bolton and Rochdale occupy shallow basins marking sites of former glacial lakes. Intervening areas exhibit hummocky landscape typical of morainic country. In general, settlement and communications follow valleys, but development of overflow channels and vigorous post-glacial erosion has sometimes caused a wide valley to be constricted to a gorge. Thus settlement has avoided the gorge of the Roch between Rochdale and Bury and that of the Irwell between Radcliffe and Farnworth.

## STAGES OF GROWTH

### 1. Before 1843

Manchester grew on a strip of firm ground between mosses to the west and moors to the east, an area in which the chief valleys of the region converged and the town became a regional market. By 1843 original sites at junctions of the Irwell, Irk and Medlock had long been obscured, and Chat and Carrington Mosses were in course of being reclaimed.

The First Edition marks some 15 toll gates in the Manchester area, every main road being effectively guarded except, by some omission, Watling Street from the southwest. A winding road passed westwards north of the mosses to link with Liverpool via Prescot, and each surrounding settlement was linked by its turnpike road to Manchester.

Improvement of road surfaces had led to increased travel and the map reveals ribbon development from Manchester along Oldham road, in Heywood and in Bury. Transport of goods, however, and especially of coal, was mainly by canal, and the First Edition shows the completed canal system as evolved during the latter part of the 18th century. First to arrive was the pioneer Bridgewater Canal, constructed in 1761 to carry coal from Worsley collieries to Manchester. The waterway, linking a district still actively being worked for coal with the industrial estate of Trafford Park, is the only one of the early canals to carry any significant traffic today; even so, it accommodates barges of only 60 to 70 tons. All others are virtually idle, serving only to provide some water requirements of adjacent works and mills.

Until widespread development of the railway, however, attraction of cheap coal led to concentration of mills and works along the canal. Many remain there owing to inertia: thus from Ashton to Manchester lies an almost continuous strip of industry flanking the Ashton Canal, while in Rochdale 23 mills border the canal and its arms.

### 2. 1843–1895

During the period the cotton industry was approaching its peak of production. Remarkable growth in the built-up area can be related to increased use of steam power, favouring as it did construction of large mills which needed extensive areas of dwellings for employees.

Manchester expanded in all directions except on to the peats of the west. Linked with rail transport, considerable area of heavy industry grew up in eastern outskirts of the city; thus between Ashton Canal and the road to Hyde were to be seen railway and engineering works, iron foundries, and

dye, chemical and gas works. Working class housing estates in the Hulme area consisted of shabby two-storied dwellings built virtually back to back, and now classed as slums. In stark contrast, yet only a short distance southwest, were detached homes of the well-to-do in Whalley Range. A completely new residential suburb arose beyond the Mersey in Sale (pop., 1901: 12,088).

Bolton and Oldham were outstanding in their growth. They furnish examples

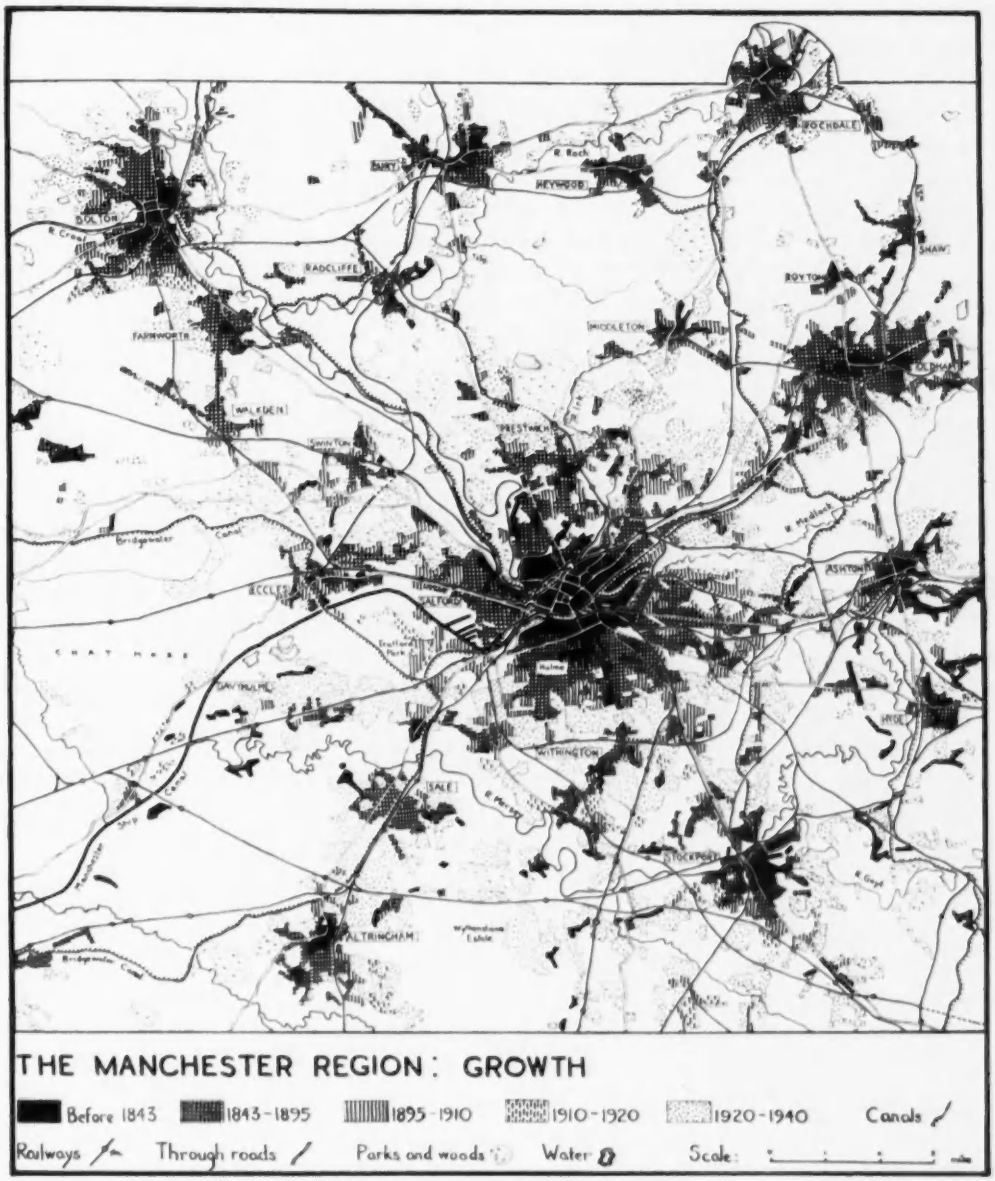


FIGURE 2.—The growth map of the Manchester region, "the busiest tract of land in all the world" is one of the most significant of such maps hitherto produced for an industrial region. The striking relationships of Manchester to the region in which it is situated and to its satellite, surrounding communities, as well as its regional growth, are revealed clearly in this almost ideal picture of its development as shown on the map.

of what Lewis Mumford has called the Non-Plan of the Non-City (L. Mumford, "The Culture of Cities," 1938, p. 183); they were nothing but agglomerations of factories and slums organised in rectangular blocks with no thought of functional planning. Thus in the great northwestern extension of Bolton were built a score of cotton mills, not secluded from the residential area, but inextricably mixed with houses, while in the western parts of Oldham arose some 40 mills with their private reservoirs, again mixed with dwellings.

Ribbon development had proceeded on a marked scale, notably in Bury, Radcliffe and Walkden. The last-named shows most clearly the evils of unco-ordinate building. Here an east-west ribbon crosses a north-south ribbon. There is a crossroads, but no centre to the straggling monstrosity; none of the side streets is more than a few yards in length. The northern arm contains seven mills and two chemical works, interspersed with dwellings; the western arm is mainly residential, consisting of a single row of houses each side of the road, with a church and a school alternating about every half mile, including, however, a large cotton mill and the pithead gear of the Manchester Collieries, Ltd., which have their headquarters in Walkden. Here two lines of the L.M.S. Railway cross, while local pits are tapped by branches of the Bridgewater Collieries Railway. Little new building has taken place since 1895.

### 3. 1895–1910

The brevity of the period—extending over only 15 years compared to the 52 years of the previous period—tends to mask the speed with which expansion proceeded. Full benefits of the railway were being reaped; but the new factor operating was the Manchester Ship Canal. Opened in 1894, in effect it converted the growing city into a seaport. In Manchester rate of construction of new houses immediately rose steeply from an average of about 750 a year for the four years previous to 1894, to reach a new average annual level of nearly 1,900 for the period 1895–1910. Similar trends were observable in Salford. (J. S. McConechy, "The Economic Value of the Ship Canal to Manchester and District," Manchester Statistical Society, 1912.

Domestic housing in the suburbs did not greatly extend the radius from the centre, but rather filled in gaps between tentacles following the main roads. In parts of the southern outlying suburbs—in Sale, Altrincham and Stockport—sprang up rows of detached houses for the well-to-do, shown on the growth map as narrow strips. Ribbon development continued in Middleton and Swinton, and Oldham became more firmly attached to Manchester.

Westward the map shows beginnings of industrial development of Trafford Park. This level, peaty area was shown on the 1st and 2nd editions as a private park, with its woodland and ornamental lake. Soon after opening of the Ship Canal the estate changed hands, the original intention being to erect suburban dwellings; but fortunately the plan, though prepared in considerable detail, was abandoned in favour of developing the area as an industrial estate. This is the earliest example in the region of industrial zoning on a large scale. Advantages offered to industry by Trafford Park include direct connections between factory and ship; access to rail and inland water transport; level land; exceptionally cheap coal; canal and artesian water in addition to public supply; and a market of 10¼ million people within radius of 50 miles. By 1912 Trafford Park had attracted 80 depots and works, exhibiting a bewilder-

ing variety of industry, but with an emphasis on those requiring heavy raw materials. To house some of the employees a dozen streets containing 600 dwellings had been constructed.

During the period there was considerable experiment in providing suitable road transport facilities, without which suburban growth would have been severely restricted. In 1895 there had been horse trams on all main roads leading to Manchester, while horse buses plied in more outlying parts. In 1901 the first electric trams appeared, and in two years the whole system was electrified. The motor bus arrived in 1906 but its influence was negligible during this and even the following period. ("A Hundred Years of Road Passenger Transport," Manchester Corporation Transport Dept., 1935.) From the 3rd edition onwards the Ordnance Survey maps, including even the edition of 1940, show electric trams serving all arterial roads of the region; in fact, however, all long distance routes, with exception of that linking Manchester and Stockport, have now been abandoned in favour of the petrol bus, or the trolley bus.

#### 4. 1910 1920

Practically all domestic building ceased during the war years. In houses which were built, for example, in the southern outskirts of Manchester, considerable garden space was preserved between parallel rows. In Trafford Park there was continued steady growth.

#### 5. 1920 1940

The map illustrates widespread yet patchy nature of development between the wars. Extensive building took place on level lands bordering the Mersey between Stockport and Davyhulme. The greater part, as in the suburbs of Stockport and Altrincham, represents activity of the speculative builder; but in this period the first comprehensive municipal housing projects were carried out. In Wythenshawe land was purchased by the Manchester Corporation in 1926; by 1938 some 8,000 houses had been erected, with crescents, culs-de-sac and large gardens familiar in modern corporation estates. A special feature of the project was the care taken to preserve existing trees and woodland. Wythenshawe is a pole apart from the 19th century "Non-Plan," but it remains a "Non-Town." Shopping facilities are inadequate; there is no civic centre; the eight factories to the north are insufficient to cater for more than a fraction of the local labour supply, and the Estate is in reality a dormitory for Manchester. It is only fair to point out that the satellite town is not yet complete: plans exist for provision of a civic centre, and as recently as September, 1945 the City Council approved construction of 1,472 additional houses northwest of the main existing built-up area.

In the northern half of the region building on an extensive scale was often discouraged by difficult topography; thus around Middleton there are areas of hummocky glacial relief which would need leveling before building would be practicable. Blocks of new dwellings appeared east of Bolton, but on the whole this town has not expanded eastwards; probably owing to the direction of the prevailing winds the most favoured residential suburbs lie to the west.

In general development was sporadic and uncontrolled. South of Stockport and in the Walkden area appear patches of housing without the least sign of co-ordination.

Extensions in Trafford Park brought the number of firms there located to a total of more than 200, employing about 40,000 workpeople. The greatest single

undertaking is the enormous plant of the Metropolitan-Vickers Electrical Co., Ltd., employing in peace time 10,000 people. Other notable works include the largest flour mill in the country; the 2nd largest power station; and a group of six oil companies. In striking contrast, a few miles to the west and southwest of this busy industrial area lie Chat and Carrington Mosses, devoid of housing. Here reclaimed black, peaty soil is intensively worked for oats and market garden produce, including potatoes, rhubarb and celery.

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In any study of growth of the Manchester region one cannot fail to be impressed by the extent of local enterprise and foresight-enterprise which produced the first canal of modern times; which drove the first passenger railway across treacherous mossland; and which in later years converted Manchester into a seaport; foresight which realised the possibilities of Trafford Park and which in modern times welcomed the first municipal airport.

One can only regret that in the past so little energy has been devoted to the problem of housing the growing population. The Manchester and District Regional Plan (R. Nicholas, "Manchester and District Regional Planning Proposals," 1945) has arrived none too soon.

In the preparation of these notes the writer wishes to acknowledge gratefully the courtesy extended to him by the Secretary of the Manchester Chamber of Commerce, the General Manager of Trafford Park Estates, Ltd., the Housing Maintenance Officer at Wythenshawe, and the Borough Surveyors of Bolton and Rochdale.

# ROCHESTER: A PROFESSIONAL TOWN

*Merna Irene Fletcher*

DUE to its health industry which has given it international fame as a medical center, Rochester, Minnesota, holds a unique place among United States cities, well demonstrated in the fact that Rochester has four and one-half times the national average of professionally employed workers. It has, since 1900, maintained the record of being the fastest growing city in the state. Rochester is now fourth city in size in Minnesota.

It became the county seat in 1858 and remains the only urban center in Olmsted County in the heart of a large agricultural and dairying section.

The city was so named because George Head, who named it, and built his cabin near the falls on the south branch of the Zumbro River was reminded of his home town in New York.

## Townsite

The original valley townsite as surveyed in 1854 was located at latitude 44° N. and longitude 92° 27′ W., near the center of Olmsted County in the valley of the south branch of the Zumbro River which enters the city from the southwest. The elevation of the valley is 1,006 feet.

Within the city limits three creeks, Silver from the east, Bear from the southwest, and Cascade from the west, empty into the Zumbro.

The city is divided into four sections—northwest, northeast, southwest, and southeast. Center Street, principal east-west street, divides the city north and south. Broadway, principal north-south thoroughfare, divides the city east and west. Streets run east and west and are named by numbers beginning with Center Street; i.e., First Street NW, Second Street NW, etc.; First Street NE, etc.; First Street SE, etc.; and First Street SW, etc. Avenues run north and south and are named by number beginning at Broadway in the same manner as the streets. Except for the area around Recreation Center, Soldiers' Field, and Plummer Circle in southwest Rochester, there is very little variation from the simple rectangular street pattern. Municipal zoning rules provide for expansion of residential, commercial and industrial areas in proper relation to one another.

## *Historical Growth*

In 1854 a party of United States surveyors were looking for townsites in what later became Olmsted County, one of 12 counties created February 20, 1855. It was in this same year, 1854, that George Head built the first log house located near the head of what has become the principal business street of Rochester today.

In 1856 Rochester was still a pioneer settlement with a population of less than 50. By 1857 the figure had risen to 600. The next year population was swelled to nearly 1,500 by a great tide of immigration. It resulted in the granting of a charter of incorporation by the legislature in 1858.

The census of 1860 showed a population of 1,424 and the population since that date has shown steady increase. The population according to the 1940 Census Report was 26,312. (For 1945

data see population table.) Since 1910 there has been uniform increase of 6,000 persons each decade.

In line with these data, a study made by sewage disposal engineers in 1945 estimates the 1965 population will reach approximately 50,000. "Projecting this curve on the basis of such a uniform increase in the year 1965, would indicate a population of about 43,000 persons for that date, making no allowances for the incorporation of suburban areas into the city. Allowances for the population of these suburbs plus reasonable growth would indicate to us a population of 50,000 persons for the city of Rochester in the year 1965."

TABLE I

POPULATION GROWTH OF ROCHESTER

| | |
|---|---|
| 1856 | 50 |
| 1857 | 600 |
| 1860 | 1,424 |
| 1870 | 3,953 |
| 1880 | 5,103 |
| 1890 | 5,321 |
| 1900 | 6,843 |
| 1910 | 7,844 |
| 1920 | 13,822 |
| 1930 | 20,621 |
| 1940 | 26,312 |
| 1945 est. | 31,020 |

Recognizing the population trend, future city planning is concerned with adequate housing and available building areas. In turn, they must be interpreted in the light of the basis on which Rochester economy rests. Statistics from the Census Housing Report indicated serious congestion in 1940. Nevertheless, there is total absence of anything comparable to a slum or shack district or area. The report showed that should the present shortage be cared for adequately by using available residential building areas, few additional vacant plots would remain if the normal number of all types of dwellings should be built.

Of available platted building areas, the Homestead Addition Development has been thoroughly planned by the Mayo Properties Association which acquired it by gift from Dr. William J. Mayo in 1935. "The Association plans to erect homes as rapidly as conditions permit . . . 14 acres to be given local school district. . . . Platted into 249 lots. Single family dwellings are to be built . . . along uniform architectural lines. All will be sold. Streets will be looped, with one chief artery extending north and south as an avenue. No curbs or gutters are planned. Sidewalks will be in the rear instead of in front of the houses. In the odd areas resulting from looped streets, playgrounds are provided. Lots will be approximately 65 x 100 feet." An allowance of 1,150 square feet of ground more per family of four in one house is more than is provided by Indianapolis in their plans for city growth. (See *Journal of Geography*, March 1945, p. 92.)

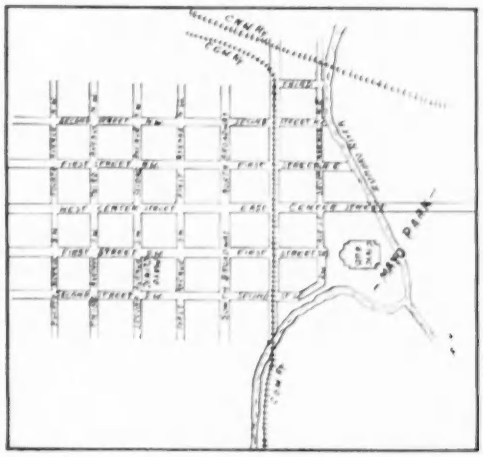

FIGURE 1.—Clinic area of Rochester: It includes most of the chief hotels, of which Rochester has 65, restaurants, stores, offices, hospitals, and theatres. The 15 story building of the Clinic dominates the city architecturally and professionally.

### *Urban Pattern*

According to the United States census of 1940, Rochester today covers slightly more than five square miles. Modern Rochester has begun to overflow the original level valley site, and residences are spreading over the tree-covered

rolling hills and ravines which surround the city.

The city seems cosmopolitan with its wide streets and tree-lined boulevards. Transportation from the business and commercial area to all residential sections is quick and convenient. City busses charging a 5 cent fare and operating on convenient, regular schedules, plus taxis with 25 cent charge for the first half mile and 10 cents for each additional half mile and no charge for additional passengers, require only a short time to deliver passengers to any part of the city. An unusual network of underground passageways for pedestrians, locally called subways, connect major hotels and hospitals with the Mayo Clinic.

Chief hotels (Rochester has 65 according to the 1945 census), restaurants, stores, offices, hospitals, and theaters are all within a few blocks of the intersection of Center Street and Broadway where they may best serve clinic visitors. The Mayo Clinic, which was begun in 1914 and completed in 1929, is located two blocks west of Broadway and two blocks south of West Center Street. The 15 story building housing laboratories, administration offices, library, etc., is completely staffed by doctors, scientists, nurses, surgical and medical assistants, technicians, and specialists in every field of medicine. It dominates the city architecturally and is the central pulse for the Mayo clinics, laboratories, and hospitals through which it operates.

Outside the commercial core of the city only an occasional grocery store or a very minor business district may be found, if the 200 rooming and boarding houses which are a major business peculiar to the city are included. They are an essential part of the health industry since they provide temporary homes and convalescent facilities for clinic patients.

The city has 350 acres of public parks and playgrounds. The largest park, Soldiers' Field, in the southern part of the city, is a complete recreational center. In Mayo Park, two blocks from the center of the city, is the Civic Auditorium, the finest of its size in the world. It is a convention and trade show center for all southeastern Minnesota.

Rochester does not resemble the usual county seat town, as one of its slogans, "Rochester, in the Land of the Sky Blue Water Plays Host to the World," implies.

The city abounds in hotels, apartment houses, boardinghouses, and rooming houses to care for the thousands who come to the clinic. "The O.P.A. reported that, on August 1, 1945, 767 rooming houses and hotels were registered with them. Knowing there are 65 hotels we assume that there are approximately 702 rooming houses." (Rochester, Minnesota, An Industrial Survey.)

The average stay of 8,000 transients, at present, is between 8 and 9 days each. Since patients stay somewhat longer, a yearly total of between 275,000 and 300,000 is obtained. Several hotels and hospitals provide interpreters for convenience of foreign visitors to the Mayo Clinics. In addition to patients, large numbers of professional and semi-professional people go to Rochester to study. (See Table II.)

TABLE II

AVERAGE DAILY TRANSIENT GUESTS

| | |
|---|---|
| Hotels | 2,800–3,100 |
| Rooming Houses | 2,250–2,550 |
| Apartments | 500– 500 |
| Tourist Cabins | 540– 600 |
| Hospitals | 1,466–1,588 |
| Private Homes | 100– 400 |
| Total | 7,656–8,738 |

"The importance of these visitors to life in Rochester cannot be too greatly

emphasized. Actually Rochester is from a business point of view a city with a population in excess of 40,000." (Rochester, Minnesota, An Industrial Survey.) The per capita hotel receipts in Rochester in 1939 were $61.85, a figure approximately four times that of other cities of its size. Retail sales are about 50 per cent higher per capita.

Based on the United States census of 1940 the population is 99.936 per cent white and .064 per cent Negro. Native born of all races make up 90 per cent of the population. The ratio of males to females is 44 to 56.

Churches are numerous in the city. The city directory carries the names of 24 churches representing many faiths and creeds.

While it is one of the greatest medical centers of the world, present day Rochester never has a morbid or sickly atmosphere. It is a friendly city where people from all walks of life and from all countries of the world meet.

The Mayo Clinic was a logical outgrowth of St. Mary's Hospital which founded in 1883 as the result of a tornado that swept the town. The Mayo Clinic, a term first used to apply to the brothers' partnership, became a legal reality in 1919. Probably the most graphic description ever given of the Clinic was written by Franklin K. Lane, Secretary of Interior under Woodrow Wilson, while in Rochester for examination. In writing to a friend he said:

"Truly, this is the most scientifically organized organization of scientists that ever was. Henry Ford could not improve upon it. Combine him with M. Pasteur, add a touch of one Edison, and a dose of your friend, Charlie Schwab, and you have the Mayo Clinic, big, systematized, modernized, machinized, doctorial plant, run by a couple of master workmen. . . . Tomorrow I am to be photographed and fluoroscoped—and then will come the verdict. . . . I guess whatever is said will be the last word—the Supreme Court of decision. Fine reputation, that, for two young chaps who never went to Harvard, eh, what?" (Clapesattle, Helen, "The Doctors Mayo.")

In 1915 the Mayo Foundation for Medical Education and Research was created, with complete access to clinic facilities, which draws hundreds of young people to Rochester for graduate study in medicine. (Affiliated with University of Minnesota.)

In 1924 the Mayo Institute of Experimental Medicine was opened on farmland donated by the Mayos. The Institute, operated by a force of expert technicians, has excellent equipment for experimental pathology, biochemistry, biophysics, bacteriology, physiology, and surgery.

Following the building of St. Mary's, through the years one hospital after another, all scientifically staffed, has been erected until today the city has 1,588 hospital beds in six hospitals exclusive of the State Hospital for the insane located just east of the city, which has an average of 1,625 patients.

The 1940 census gives some basis for saying that Rochester is a professionally-minded city as compared with other United States cities. At that time there were 217 professional workers per 1,000 employed, and 30 semi-professional per 1,000 employed. This means nearly 25 per cent of all employed were in the above classes. (For comparison with other industries see Table III.)

According to the 1940 census report, 11.4 per cent of all employed females in the entire United States are engaged in professional work. In Rochester 32.3 per cent of employed women are so employed. The figure for males is 4.1 per cent for the nation and for Rochester 14.1 per cent. Of total employed work-

ers in the United States 5.9 per cent are listed as professionally employed while the percentage is 22.0 in Rochester or four and one-half times the national average.

Such dissimilarities also exist in other non-domestic service fields where 4.3 per cent of the nation's males and 11.1 per cent of the females are employed, but in Rochester figures are 13.4 per cent and 22.2 per cent respectively.

The figures clearly indicate the type of people who dominate Rochester's life but it should be remembered that they represent only the resident population, and do not include the thousand and more doctors, nurses, students, and scientists who are in Rochester for various lengths of time for observation and training purposes. (See Table III.)

TABLE III

LABOR STATISTICS, MAY, 1940*

| *Industry* | *No. Employees* |
|---|---|
| Quarrying | 94 |
| Finance, Insurance, Real Estate | 184 |
| Transportation, Communication, Utilities | 221 |
| Manufacturing | 568 |
| Construction | 771 |
| Personal Services | 1,248 |
| Professional Services | 1,807 |
| Retail and Wholesale | 2,480 |
| All Others | 52 |
| Total | 7,425 |

*Firms employing less than eight were exempt from reporting so total does not represent all employed persons.

Following the same trend of thought one may well consider educational characteristics of the local population. In the United States, at large, one out of 22 adult males (only 4.7 per cent) are college graduates while in Rochester one out of every 9 (11+ per cent) have had such education. In the state 4.9 per cent of the adult males have attended college 1 to 3 years, in Rochester 7.4 per cent have done so. In Rochester the average adult male has attended school 9.3 years which is the best record for any community in Minnesota. Figures for females are even more distinctive. Of all adult females in Rochester 6 per cent are college graduates while in the state, at large, only 3.4 per cent have had such education. Of the remainder of Rochester's women 11.5 per cent have had 1 to 3 years of college training while only 8.4 per cent in the state have had such education. The average woman in Rochester has had 11.2 years in school while for the state of Minnesota the figure is 8.7 years.

The census also shows a relatively high ratio of women employed in Rochester—82 for each 100 men, explained by the fact that medical and allied services, such as nursing for patients, constitute a major employing factor where women are in service.

Study of wages paid to various industrial employees of Rochester shows that 59.25 per cent goes to the service industries.

For a number of years Rochester had one of the largest per capita income tax returns in Minnesota. Over 9,000 individual returns were made in 1942.

All such facts are reflected in the standard of living of the town. A relatively well-educated and professionally-minded town has costlier level of acceptable living and exerts greater pressure on the individual to live up to that level than a town whose atmosphere and standards are set by factory mechanics or retired farmers. In Rochester a far higher than average number of homes are provided with radios, telephones, gas or electric cooking stoves, and mechanical refrigerators. All homes in Rochester are wired for electricity. Further data on radios and telephones are found in the section on communication.

In the survey of goodness of living conducted in 310 American cities by E. L. Thorndike of Columbia University and his staff, the total of properly weighted scores indicate that Rochester ranks

with the best residential suburbs of the United States.

From the outset the Doctors Mayo, father and sons, realized that Rochester must be able to compete with larger cities in this matter of "goodness of living" if they were to attract well-trained, capable, professional men to settle there. They were convinced that any improvements would be to their advantage and render service to the city as well. So they decided to spend one-tenth of their income for such projects.

"That policy systematically continued and expanded was the chief means of giving to Rochester physical features and facilities for recreation, education, music, and art that are unusual, if not unique, in American cities of its size. And the practical purpose was achieved —that good men who were otherwise willing to join the Mayos should not be deterred by the disadvantages of Rochester as a home." (Clapesattle, Helen, "The Doctors Mayo.")

It should be remembered that the

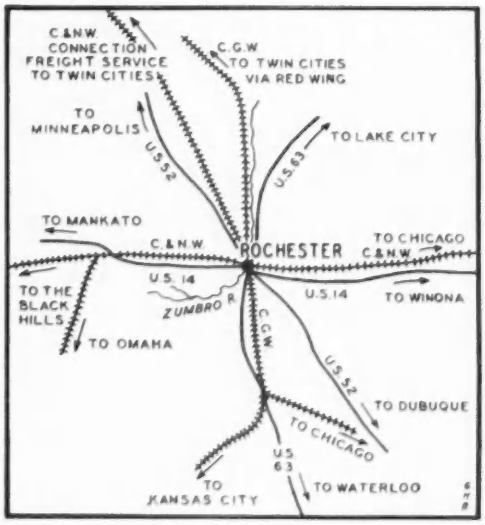


FIGURE 2.—Highways and railways radiating from Rochester: They give the whole world easy access to this northern prairie city, famous wherever health, medicine and surgery are discussed.

Doctors Mayo also gave unstintingly of their personal efforts by holding offices and by serving actively on the city council, school board, board of health, and numerous civic committees.

In its entire history there has been very little labor unrest in the city. Employees and manufacturers usually meet to iron out their grievances. There are A. F. of L. unions covering workers in sixteen fields and more recently C. I. O. has organized the service workers.

While Rochester's city area in August 1945 had 31,020 residents, the Keiter directory reported also 1,800 suburban residents and 8,000 transients in addition.

*Transportation and Communication*

From 1849 to 1870 southeastern Minnesota was criss-crossed with roads for pioneer stagecoaches bringing settlers. The early roads are for the most part routes of modern highways. Rochester is at the intersection of three U. S. highways—Nos. 14, 52, and 63, giving it excellent road connections in all directions. Four bus lines connect the city with all points north, south, east, and west. Twelve motor truck lines and numerous independent and contract haulers use the radiating highways. Two major railway systems, the Chicago and Northwestern Railway and the Chicago Great Western Railway, provide the city adequate freight and passenger service. The Rochester airport, formerly owned by the Mayo Properties Association and since deeded to the city, is one of the best equipped in the country. It provides direct air connection from coast to coast and from Canada to the Gulf. The Mid-Continental Airways and Northwest Airlines each operate six flights to and from Rochester daily. A passenger may board a plane in mid-afternoon and arrive in New Orleans that evening

without changing planes. Northwest Airlines provide coast to coast service. All air service is highly important to the transient business flowing in and out of Rochester. The present air passenger service takes care of over 100 people daily.

Rochester is greatly interested in a project for improvement of doc service at Lake City 36 miles to the north on the Mississippi River. Should the project materialize it will mean an easily accessible river port for Rochester.

Of Rochester's 90 miles of city streets, 38 miles are paved, 34 miles are oiled gravel and 18 miles are gravel. With one exception, the bridge across the Zumbro on Center Street, there are no restrictions on bridges. A planned postwar project is replacing this restricted bridge.

The Southern Minnesota Broadcasting Company with headquarters in Rochester owns and operates radio station KROC. The station is affiliated with both the Blue Network and NBC. KROC is the only radio station in the metropolitan area which gives static-free reception. Ninety-six and eight-tenths per cent of the homes in Rochester are radio equipped, the highest percentage of any Minnesota city.

Northwestern Bell Telephone Company supplies telephone service to the city. Total telephone installations, as of 1945, show residential 5,338 and business 1,159. Standard dial telephones are used.

Mail service is excellent. No other city of less than 50,000 in population has such air mail service.

Telegraph facilities are about like those in any other city but accommodations are more convenient because of the thousands of transients.

### *Results of Location*

Rochester is fortunate in its location in the heart of Olmsted County's rich agricultural and dairying lands. The census of 1900 showed Olmsted County to be one of the richest agricultural counties in the United States, flourishing on its production of pigs, sheep, cattle, butter, and small grain; a far cry from a few decades earlier. In that year Minnesota's commercial, industrial, and financial activities were booming.

"It was those developments that enabled thrifty farmers, laborers, and professional men to build better homes, buy better furniture and clothes, and send their sons to high school and to the state university—and finance a trip to Rochester for themselves or their wives for expedient physical repairs.

"All these factors may serve to explain how the Mayos developed at Rochester a center of surgery in Minnesota." (Helen Clapesattle, "The Doctors Mayo.")

Today wheat farming of the pioneers has given way to diversified farming. Most farmers of the county now obtain major part of their cash income from cattle, hogs, and poultry. Most dairy products are sold to creameries of which the Rochester Dairy Coöperative is the largest. Corn and hay were formerly chief crops, but since the Reid-Murdock canning factory opened, large quantities of sweet corn and peas are grown as cash crops. Olmsted County ranks fourth among Minnesota counties in production of cheese. Thus nearby farms help maintain two of Rochester's outstanding industries—milk processing and vegetable canning.

Winters are long in Rochester. Average date of the last spring frost is April 29 and of the first autumn frost is October 9, giving an average growing season of 162 days. The longest growing season ever recorded was 212 days in 1900, the same as the average for southeast Missouri. The shortest was 110 days in 1917. Snow falls normally

in all months except June, July, August, and September. Of the snowy months, lightest snow fall occurs in December and the heaviest in March. The 52 year average snow fall in inches and unmelted is 43.5 inches. Average annual precipitation is 28.5 inches, heaviest amounts being recorded in the growing season. A 39-year average shows the city as receiving a total average of 57 per cent of the possible sunshine with a minimum of 40 per cent in December and a maximum of 73 per cent in July. Such combined factors necessitate much greater use of public utilities. However, Rochester enjoys one of the lowest utility service rates in the country. The city owns and operates its own hydro-electric power and steam plant, and water system.

The city water supply is obtained from deep and shallow wells. The latter penetrate to St. Peter limestone at about 70 feet. The former, of which there are 17, go down to Jordan limestone at 350 to 500 feet and provide a much safer supply since the water enters the sandstone in the Mississippi River Valley. The shallow well water comes from the upper surfaces of the Shakopee phase due to seepage through alluvial deposits. The water is only moderately hard, has practically no turbidity, and contains very little iron. Its PH value (refers to acidity or alkalinity) gives it a neutral rating.

Natural gas has been piped to Rochester from the Panhandle district in Texas, a distance of about 750 miles. Nearly 5,000 homes are heated by gas.

### *Trade and Manufacturing*

Large metropolitan distribution centers are economically necessary in certain areas of business life. In some other areas smaller distribution centers are a real advantage. Rochester's peculiar needs seem to fit it in well with the latter group. It is the logical trading center for southeastern Minnesota and its excellent highways give exceptionally good bus service. The 1940 census of business lists 38 wholesale establishments doing a business of $4,506,000 in 1939. The total employed was 189 and the average worker compensation was approximately $1,500, a value of $171 per capita to Rochester's wholesaling business in 1939. Comparative value for retail trade was $602 per capita and for strictly manufactured products $240 per capita. Among principal products handled by wholesalers are automotives, groceries, baker products, tobacco, beer, beverages, tires, meat, flour, farm products, and petroleum.

In retail trade Rochester's territory has expanded from year to year and now extends from 25 to 40 miles in various directions. The immediate trading area has a population of 80,000 people.

There were 322 retail stores in Rochester in 1945 doing a business of about $22,181,600. They employed nearly 1,900 people with a payroll of $1,845,000. Filling stations headed the list in number of establishments with 65 followed by groceries and meat 55, restaurants 45, clothing 26, beer and liquor 22, and automotive 11.

Because of transient trade, retail sales are high. It is estimated that visitors spent $8,000,000 annually for retail purchases other than medical supplies. Since many of the transient population represent upper income brackets, Rochester stores are usually well stocked with high grade merchandise in the latest of styles.

Rochester's growth as an industrial and manufacturing center has accelerated recently. There were 46 manufacturing concerns in Rochester in July 1945, employing approximately 1,600 persons, not including seasonal labor

for the canneries, with annual payroll of about $2,000,000.

Among best known of Rochester's plants is the before mentioned Rochester Dairy Coöperative, a farmer-owned organization which does business in 11 Minnesota counties, 7 Wisconsin counties, and 3 Iowa counties. Within the area the institution has 2,400 direct and 2,000 indirect patrons to whom its total cash payments for the year ending September 30, 1945 exceeded $7,850,000. A milk drying plant, one of the finest in Minnesota, was built in 1944. Another plant to be built in the near future, will put Rochester well on the way to becoming one of the largest milk processing centers in the country. Increased use of dried milk, ice cream mix, condensed milk, milk powder, and casein, all of which are manufactured here, assure the organization a bright future. The plant is now looking toward tropical and subtropical markets.

Other manufactures based on agricultural raw materials are vegetable processing and bakery goods. A large modern bakery serves Rochester and a wide surrounding area.

Other manufactured goods, for many of which Rochester has no more natural advantages than many other American cities, are oil burners, piston rings, cosmetics, portable phonographs, therapeutic bakers, carbonated beverages, and neon tubing. According to the Rochester *Post Bulletin* until war broke out "The Conley Company manufactured phonographs, hemp massagers, auto windshields, toy telephones, camera bellows, photograph printing frames, oak letter trays, special cabinets, carpet sweeper wheels, and rocker duplication units."

It will be seen that manufacturing in Rochester, while highly important, certainly does not dominate the city's economy. All business activity in Rochester must be considered in the light of her unique health industries centered about the Mayo Clinic. A comparison with other Minnesota cities indicates that Rochester has the smallest proportion of her labor force employed in manufacturing (2.16 per cent) and only 11.1 per cent in all industry as against nearly 25 per cent in professional work. Hence we find service industries of all types including professional, scientific, educational, and financial become the major activities, and the validity of the statement that Rochester is a professional town becomes evident.

Here, in this valley town of southern Minnesota, this "little town on the edge of nowhere," is one of the world's greatest medical centers to which men come from all over the earth for treatment and instruction, to heal and to be healed.

Here through singleness of purpose, relief of human suffering, professional men and women have built not only a great medical center but a professionally-minded city.

# BOOK REVIEWS

HARRIS, SEYMOUR E., et al. *Economic Problems of Latin America.* Published by McGraw-Hill Book Co., Inc., New York and London, 1944. Price $4.00. XIV and 465 pages.

HUGHLETT, LLOYD J., et al. *Industrialization of Latin America.* Published by McGraw-Hill Book Co., Inc., New York and London, 1946. Price $5.00. IX and 508 pages.

ELLSWORTH, P. T. *Chile. An Economy in Transition.* Published by The MacMillan Company, New York, 1945. IX and 183 pages.

The sustained and growing interest in Latin America, and the "good neighbor policy," have led to the writing and issue of numerous books on the geography, history, and economics of South America, and Central America. Such books have been necessary, because our people of the United States have been all too ignorant of the ways and customs, and the resources and physical conditions of their neighbors to the South. Socially, economically, politically, and strategically, those neighbors have become increasingly important to us, and our people must become better acquainted with their relationships to us and our affairs. Every book that is published about our Latin American neighbors that has any merit or significance at all, is just so much to the good.

The first volume listed "Economic Problems of Latin America" is written by seventeen economists, each of whom has been active, or is still active, in government service, and is considered an expert in the field or area that he covers. Doctor Seymour E. Harris, Associate Professor of Economics, Harvard University, is the Editor, and writes the introduction, and two other chapters. The chapter on "Chile" is written by P. T. Ellsworth, author of the third book reviewed in this series. The introduction comprises Part 1, and states the problem and describes the area as a whole; Part 2 is devoted to general considerations; and Part 3 treats of special individual countries—Argentina, Bolivia, Brazil's Economy in the War and after, Chile, Colombia with particular reference to price control, Cuba—its sugar and currency, Haiti, Mexico with special reference to its international economic relations, Paraguay with particular reference to price control, and Venezuela.

For so composite an authorship, the book achieves respectable integrity of fact and style, and a well focused perspective. It represents the most authoritative compilation and interpretation of subjects with which it deals yet available, and for that reason, if for no other, will find a place on every adequate reference shelf of Latin American books. It emphasizes international factors in the economy of each and all Latin American lands and the imminence and significance of excessive inflation; the problems of stabilization of currency and economic relations; the position of labor and the significance of our good neighbor policy.

Treatment of the several special countries measures up to the best standards of geo-economic organization, naturally with only a modicum of geographic material and major emphasis upon economic causes and effects. Each one of the regional chapters is authoritative and adequate in the field that it presents. Though conditions may change rapidly in the future, as South America is transformed from a pioneer economy to a settled economic and political condition, for the current view and interpretation of the several countries the book affords authoritative and interpretative material.

The second book in the series, "Industrialization of Latin America," and published by the same firm, is somewhat similar in its organization, but instead of dealing with economic affairs almost exclusively, it takes up the several manufacturing enterprises of the Latin American countries, and treats them in detail. The mining industries receive the most inclusive attention, as is natural in a region where raw materials, particularly minerals, are the source of so much wealth, and the basis for so much activity. The metal-working and chemical industries rank second in importance, with the sugar industry almost as adequately discussed. Even in an industry so closely related to geographic conditions as fishing, geographic factors are practically neglected. As a consequence, the book is of only secondary importance to the geographer, an indirect reference that the geographer will rarely use.

The third book under review "Chile. An Economy in Transition" does not form part of a series, but is an independent book published by another firm. It is strictly economic in its material and point of view, but does offer a considerable mass of facts germane to the field of geography. The economic geographer will probably find some measure of good material in the book for his discussion of Chile and its development.

Altogether, the three books, while of importance to the economist, and perhaps to the industrialist, are of relatively secondary importance to the geographer. The geographer may find scattered through the wealth of textual material, some wheat for his grist, but most of it belongs strictly in the field of Economics.

W. E. E.

WRIGHT, JOHN KIRTLAND and PLATT, ELIZABETH T. *Aid to Geographical Research.* Published by American Geographical Society, New York. Second Edition 1947. Price $4.50. XII and 331 pages.

Since the issue of the First Edition of this book, a wealth of geographical literature has been published, a whole new phalanx of geographers, both in America and elsewhere, has burst into print with great richness of material, not available at that time. The present edition includes all the new personalities, publications, institu-

tions, and multiplicity of geographical articles. Valuable as was the first edition, the second is a distinct and substantial improvement upon it. The entirely new introduction affords an easy, systematic approach to a field that has expanded with unparalleled rapidity in the quarter century since the issue of the first edition.

Needless to say, the professional geographer cannot dispense with this new volume. It must find a place upon his shelf with the rest of his indispensable books. The research worker and the teacher both, must keep it ever at hand. As a bibliography, list of periodicals and atlases, and general reference book in the field of geography, particularly American geography and for the American geographer, it is in a class by itself. There is nothing like it in our language, so far as usefulness, inclusiveness of subject matter, and reference value is concerned. Like all other publications from the American Geographical Society, it is exhaustive and authoritative, as trustworthy as any such publication can possibly be.

W. E. E.

Hobbs, William Herbert. *Explorers of the Antarctic.* Published by House of Field, Inc., New York. 1941. Price $3.00. 334 pages.

In belated review of Doctor Hobbs's monographic study of the exploration of the Antarctic, the reviewer would state that the volume constitutes so important a source reference upon the part of the world about the South Pole, which has hitherto been neglected, and which is assuming unexpected significance in world affairs that it can no longer be neglected, as, unfortunately, it has been. In the same way that Greeley and others summarized the exploration of the Arctic, so Hobbs has in this volume even more adequately recounted the epic saga of the Antarctic. As long as there are explorers and geographers and adventurers, this first complete and exhaustive monograph on the Antarctic will remain a primary source of authentic and detailed material.

Written in the fluent, lucid style for which the author has become so well known in more than a score of books, the account runs along like a clear, white-water stream from its source in the mountains to its outlet in the sea, with all the interesting variety and diversity of point of view and enchanting vistas that such a stream affords. It is just as fresh as mountain water in its style—in places just as sparkling and ripply, in places deep and fraught with deeper meaning. It has all the charm and interest and educational value that such a source book should have.

Doctor Hobbs has long been a specialist on polar research, long a critical student of the history of Antarctic exploration, long a protagonist of Nathaniel Brown Palmer, the redoubtable Connecticut Yankee, as the original discoverer of Antarctica, the last of the great continents to be discovered. As he gives credit to Palmer for its discovery, so he gives credit to Charles Wilkes, the American navy commander, for proving its continentality. He takes up all the men who have made Antarctic history, and gives them their due meed of credit and praise. He makes the Antarctic a ranking continent in strategic and historical significance.

W. E. E.

Bennett, Hugh Hammond. *Elements of Soil Conservation.* Published by McGraw-Hill Book Company, New York and London. 1947. Price $3.20. X and 406 pages, and many illustrations.

"Elements of Soil Conservation" does credit and honor to its author. It is a compendium of applied conservation, with a minimum of propaganda and journalistic argumentation, so likely to creep into a book on conservation, since conservation became a political platform upon which aspiring politicians could rise to high position or high salaries. In the last ten or fifteen years there has been altogether too much tendency to make conservation, and particularly soil conservation, a political football, ignoring its soundly scientific requirements and applications.

In this "Elements of Soil Conservation," Doctor Bennett restores conservation to its proper and perfectly sound position as a scientific technique and public problem, and gains for the subject, as for his book, support that more popular appeals have lacked. Every course in conservation, whether it be in a department of economics, or sociology, or of geography, can use this book to good advantage and with good results. The student will be more easily convinced by the scientific approach to the subject that this book represents, than by any ponderous tomes of popular advocacy or untrustworthy, but subtle argument. As an authoritative and convincing book, it deserves a place on every geographer's reference shelf. It can well be used as a basic text in a Liberal Arts course, preparing for citizenship; in a teachers college preparing men and women for careers in education; and as an introductory text in a college of commerce, or a college of agriculture.

The book is well and attractively bound, the type is easy and comfortable to read, the style is fluent and convincing, and except for rather indifferent reproduction of photographs, constitutes an excellent example of the printer's and bookbinder's work, as well as the author's training and ability.

W. E. E.

## ECONOMIC GEOGRAPHY

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The January issue of Volume 23 contains the following articles:

*Alkali Problem of Western United States*, Harold A. Hoffmeister, University of Colorado, Boulder, Colorado.
*Peasant Life in the Glens of Antrim*, Eila M. J. Campbell and U. Donnelly. Miss Campbell is associated with Birbeck College, University of London, London, England, and Miss Donnelly at Carshalton House Collegiate School, Surrey, England.
*Banana Trade of Brazil*, Earl B. Shaw, State Teachers College, Worcester, Massachusetts.
*The Central Valley Project: 1947*, Elizabeth Eiselen, Wellesley College, Wellesley, Massachusetts.
*Recent Dairy Market Orientations*, Loyal Durand, Jr., University of Tennessee, Knoxville, Tennessee.
*Southeastern Littoral of Korea*, Shannon McCune, Colgate University, Hamilton, New York.
*Economic Rehabilitation in Eire*, Harold E. Hall, Office of International Trade, Washington, D. C.
*New Cotton Belt in China*, Hu Huan-yong, National Central University, Nanking, China.
*Settlement Pattern of the Listowel Region*, D. W. Kirk, Northwestern University, Evanston, Illinois.
*Cities of Central Missouri*, Robert M. Crisler, Northwestern University, Evanston, Illinois.

The October issue of Volume 22 contains the following articles:

*Northern Great Plains as Producer of Wheat*, Ralph E. Ward, Department of Agriculture, Lincoln, Nebraska.
*Colombia's Petroleum Resources*, Phyllis R. Griess, Pennsylvania State College.
*Great Kanawha Valley*, Leslie M. Davis, Marshall College, Huntington, W. Va.
*Mineral Resources of Indo-China*, E. Willard Miller, Pennsylvania State College.
*Physical Aspects of the Laramie River Dispute*, Clark N. Crain, Denver University, Denver, Colorado.
*Land Utilization in Central Ontario*, L. G. Reeds, University of Toronto, Toronto, Canada.

The July issue includes:

*French-Speaking Farmers of Southern Louisiana*, Walter M. Kollmorgen, University of Kansas, Lawrence, Kansas, and Robert W. Harrison.
*Aridity of the Southern Hemisphere Continents*, Benjamin Moulton, Indiana University, Bloomington, Indiana.
*The Industries of Bristol*, Frank Walker, University of Bristol, Bristol, England.
*El Salvador*, Minnie E. Lemaire, State Teachers College, East Stroudsburg, Pennsylvania.
*North Carolina Flatwoods*, Samuel T. Emory, University of North Carolina, Chapel Hill, North Carolina.
*Pecan Industry in the United States*, Isabel K. Billings, Oak Park, Illinois.

The April issue includes:

*Aluminum Industry of Europe*, James E. Collier, Fresno State College, Fresno, California.
*Turning of Tirnovo*, George D. Hubbard, Oberlin, Ohio.
*Petroleum Import Policy of the United States*, Olin T. Mouzon, University of North Carolina, Chapel Hill, North Carolina.
*Hemp: A Minor American Fiber Crop*, John H. Garland, University of Illinois, Urbana, Illinois.
*Birmingham and the Black Country*, Henry Rees, London, England.
*Twin Cities of Waterloo and Kitchener*, Chun-fen Lee, Washington, D. C.
*Role of Pueblo Indian Economy in Santa Fe*, Irene A. Moke, Washington, D. C.

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